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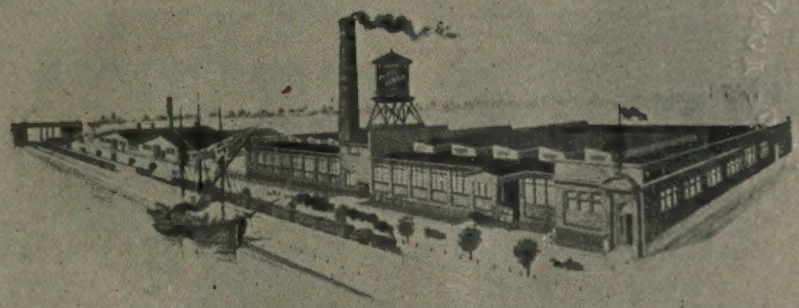

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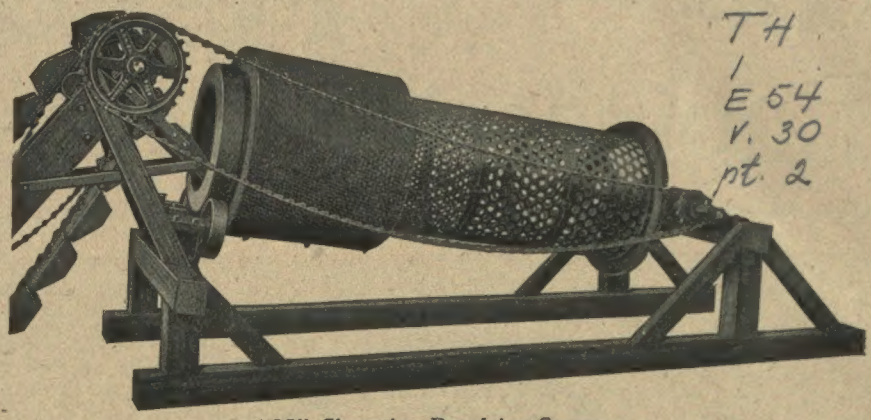

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Day Labor and Contract Work

THE marked difference between the cost of day labor and contract work is illustrated by a statement prepared by the sewers department of the engineers' office of the Montreal Council and presented by Mr. P. Mercier, the chief engineer. Many of the aldermen naturally favor the former, as it gives openings for patronage, lessening the efficiency of the department by forcing in men of little or no experience. This is the chief factor in the high cost as compared with the contract system, under which firms naturally try to obtain work at the smallest expenditure. In the construction of 2 x 3 ft. brick sewers the cost by day labor and contract was respectively: in 1913, $15.53 per lineal yard against $16; in 1914, $33.14, against $12.25. In 1915 and 1916, day labor alone was employed, the cost being $23.75 per lineal yard in the former year and $29.14 in the latter year. One of the divisional engineers states that, taking the four years, the cost is 44.68 per cent. higher for day labor, and he puts this down to the lack of latitude enjoyed by the city engineers in choosing their foremen and assistants, and the want of freedom of the latter in choosing their laborers, all of whom are paid 25c. an hour. Interference by ward politicians with foremen in directing the men is a source of expense.

In summing up the various reports of the three divisional engineers, Mr. G. R. MacLeod, the engineer superintendent of the sewer department, says: "I think that one of the principal reasons for the increased cost of sewers built by day labor as compared with contract work is the fact that most of the sewers built by day labor were built during the winter seasons of 1915 and 1916, although this is only partially true. There is no doubt but that the cost of doing such work in winter and spring is much higher than in summer. I am informed that at the beginning of 1915 the engineers of this department protested in writing against building sewers in winter, stating that the cost would surely be increased.

"The second great reason for the increased cost of this work since adopting the practice of building by day labor is the increase in rates of wages, for laborers from 20 to 25 cents an hour, and for carters, single, from 31.5c., double 55c., to carters, single 37.5c., and double 60c. per hour.

"A third important reason for the increase in cost per lineal yard of sewers is that for engineering reasons the depth of the sewers has been increased from 9.9 feet in 1913, to 12 feet in 1916.

"There is no doubt that notwithstanding the special circumstances mentioned above, the city could get sewers built by contract cheaper than by day labor, especially when it happens that a large number of sewers are under construction at the same time. It is a well-known fact that under the day labor system, **there is a constant tendency to force inexperienced or indifferent foremen, bricklayers and laborers upon the construction forces of the city,** and this evil is accentuated as the number of sewers under construction at one time is increased."

A Reflection on Our Educational System

WITH further reference to our editorial in last week's issue on "Distant Fields Look Green," it has been brought to our attention that the matter of which we complain, which is chiefly the employment of foreign engineers, architects, etc., when we have equally good men at home, is a decided reflection on Canadian institutions of learning. We have a number of universities where engineering in its various forms is taught and where very large sums of money are spent annually in turning out men specially suited, one would suppose, to carry on the business and development work of our own country. Is it not equally incongruous and anomalous that our governments should vote large sums of money to cover the expenditures of our educational institutions and in the next breath sanction the employment of professional men educated in foreign institutions? Yet this is happening almost daily. Is it the poorer raw material represented by our student-body, the limited equipment of our engineering colleges, or the inferior instruction given in them, that must bear the brunt of the blame? Surely not. We like to believe that our young men are as bright as

can be found anywhere, that the equipment of some of our laboratories is equal to that found elsewhere and that our teaching staffs rank equally with those of similar institutions in other countries.

It looks more and more as if professional "etiquette" (or whatever that attitude of mind may be called which prevents any man from placing his qualifications before the public), were standing in the way of no one quite so much as our Canadian engineers and other professional men themselves. In the olden days practically every line of trade and commerce was carried along on the "if any one wants me they know where to find me" basis. To-day matters are entirely reversed—it is pre-eminently an age of "going after" business. Professional men, however, still cling to the old habits. "Etiquette" would stand aghast at a medical practitioner suggesting a tonic except on a definite request. No matter if a good citizen die, the ethics of the profession must be observed. The legal profession is little better and the engineering profession is much worse—if possible. In one or two instances, it is true, Canadian engineers in recent months have endeavored to take the saner and more truly national point of view and have actually offered advice. That it has been rejected is no proof that their course was in error, but simply illustrates the attitude of mind of the layman towards professions in general—and the professions have only themselves to blame.

Can you imagine the difference between the life insurance business, for instance, as it is to-day and as it would have been if this same policy of "sit down and wait" had been followed? The members of the engineering profession may well study the business-getting methods of these men. No line of action is unprofessional or undignified if it tends to improve the well-being of the nation and on this basis no body of men could, with more justice, argue in favor of greater aggressiveness. If our engineers believe in themselves and if our educational authorities believe in their own products, surely in this day and generation it could not be considered infra dig. that these facts be published much more widely so that the general public be acquainted with the facts. With the principle of equality of the home product once established in the public mind there is little reason to doubt that the national pride and loyalty of our municipal and other authorities will do the rest.

Report on Georgian Bay Canal

An interim report on Certain General Conditions of Transportation Bearing on the Economic Problem of the Proposed Georgian Bay Canal, has just been issued by the Dominion Government. The report is prepared by W. Sanford Evans, chairman of the Georgian Bay Canal Commission. In the introduction, Mr. Evans recites briefly the history of the proposed canal and the preparation of the plans and estimates, which provide for a waterway, 22 ft. deep with a length of 440 miles, in which there would be 28 miles of canal excavation, 66 miles of channel dredging, and 364 miles of lake and river. The plans call for 27 locks of a minimum length of 650 ft., 65 ft.clear width and 22 feet deep, with lifts ranging from 5 to 50 ft., and with a minimum supply of water permitting of 20 lockages a day throughout the navigation season. The cost, originally estimated at $100,000,000, was later increased to $125,000,000, and the Georgian Bay Canal Commission was formed to consider whether it would pay Canada to expend this amount of money upon this public work.

The report points out that great public works, such as railways and canals, may be undertaken for political, military, or economic reasons, but that the present investigation deals only with the economic side of the construction of this canal. It is pointed out, however, that the report does not take into consideration any possible collateral values which may be created by the building of this canal, nor the development of local trade, but solely with the problem of through traffic. This interim report is published pending the completion of the statistical survey of the principal facts and conditions entering into the transportation problems which must be made before a final and definite report can be submitted. As indicating the scope of the work carried out to date, the following chapter headings may be noted: freight traffic to and from Lake Superior; number, capacity and nationality of vessels; load factor; total traffic by principal commodities; traffic to and from Lake Michigan; future development of traffic; the routing of export wheat; ocean freight rates in 1915, followed by certain statistical tables. The report is illustrated with some 24 graphic figures.

Zinc Deposits in Ontario

There are many well-known zinc deposits in Ontario, but operations have not been carried on in the mines during recent years owing to the prevailing low prices. Greater interest is now being shown in the deposits, since the present scarcity has increased the value of the metal. There is a possibility of working the mines at a profit if the present remunerative prices continue.

The chief location of zinc ores in Ontario is in the Lake Superior district. The old Zenith mine, 12 miles from Rossport, near Lake Superior, supplied 2,000 tons of ore, 45 per cent. zinc, during 1900 and 1901, but the mine was shortly afterwards abandoned on account of the low price. Other smaller and less fruitful deposits occur in the Thunder Bay and Timiskaming districts. A mine is located in Frontenac county, near Kingston, and was productive from 1905 to 1910.

The total production and value of the zinc ore mined in Canada during 1910 to 1913 were: 1910, 5,063 tons, value $120,003; 1911, 2,590 tons, value $101,072; 1912, 6,415 tons, value $215,149; 1913, 7,535 tons, value $400,000. The Ontario production in 1909 was valued at 8,950; in 1910, $5,760; since 1910 no further yield was reported. The greater part of the Canadian ore comes from British Columbia and was formerly refined in Kansas and Oklahoma, but an electric reduction furnace is at present in operation in the Rossland district.

Regina Branch, C.S.C.E.

The Regina branch of the Canadian Society of Civil Engineers held its regular meeting on June 22, with Mr. O. W. Smith, chairman of the branch, presiding. The feature of the evening was an address by Mr. C. D. Howe on the construction of terminal elevators. Mr. Howe described in detail the functions of the various types of elevators with their constructional features and necessary equipment. Interesting slides depicted many of the structural details. Other speakers included Mr. W. M. Martin, M.P.; Mr. R. J. Lecky, Mr. C. A. Dunning, and Mr. F. Hedley Auld, Acting Deputy Minister of Agriculture. The meeting closed with a short talk by Mayor Cowan on the responsibilities and opportunities of engineers in the development of the country.

Relation between Engineers and Contractors

The Successful Contractor of Today has Technical as well as Practical Knowledge—Some Suggestions on the Wording of Agreements (Con.)

By J. W. Rollins

We contractors do not see why we should have to fight for justice in such cases as these.

We make our proposals on the basis of the information furnished us, and this information is generally the true and best judgment of the engineers who are doing the work. If then conditions develop which neither party ever considered, why in the name of justice and fair play should the contractor have to suffer?

Some of the trouble comes from the fact that the principals in many cases will not allow the engineer to make sufficient investigations to determine with reasonable accuracy the exact conditions.

Another trouble comes from the fact that public authorities do not dare to make a just settlement as against the strict legal interpretation of the conduct, and when it comes to this interpretation it is a legal one and nothing else. Some legal decisions, and by our highest court, are so absurd that even we contractors have to smile at their absurdity.

Much trouble comes to contractors and the engineer is often placed in an embarrassing position, when orders are given by the latter for extra work, or contractors are told to go ahead and do the work and he will see that they get paid for it. In my early work as a contractor we used to go ahead and do anything the engineer asked us to do, with full confidence that we would get paid, and we generally did. It would never do to stop to discuss matters as to extra work, when we had a railroad track up on posts and all trains slowed up to cross on them. We would have been fired off the road for good and forever, if we had taken this course, though probably the contract expressly provided that no extra work should be done without written orders from the chief engineer.

We contractors are willing to give and to take, to do any little thing an engineer wants, even if outside the contract; it's our policy, if we are wise, to keep on the good side of the engineer and trust he will return the favor in the same way, and for that reason we are reluctant to make a claim for extra work in these cases, as such a claim would not make us popular, and so we fail to comply with the conditions of the contract which require that claims must be made in writing within a week or two after the work is done.

Protection of Contractor

To-day, however, the engineers stick so closely to the specifications that they cannot do us any favors, and we have to look over the contract more carefully and comply with all the legal requirements. To be absolutely safe a contractor should refer all contracts he proposes to bid on to his attorneys, and should have one at his elbow to advise him throughout its continuance.

We got into very serious trouble in building a section of the New York subways from our neglect to safeguard our work in this way. We asked permission to build a power house in Union Square, and it was given us by the Transit Commission and other public officials. We built the power house opposite a hotel, the lessee of which promptly sued us for damages. We won in the first court, lost in the second and Supreme Court, and finally paid $98,000 in damages; the court holding that the Transit Commission and others had no authority to give us this permission, but that it should have been asked for and obtained from some other commission.

We just escaped a more serious loss in another case: We contracted to build a bridge in Massachusetts costing $800,000, across a deep river near tide water. The plans were meagre, giving no details, simply showing piers on rock bottom 60 feet below water, and on piles 40 feet below water; the contract specifying that the contractor shall submit plans showing the method of constructing the foundations, to the engineer for his approval, and also stating: "the work shall be done as shown on plans," and that changes could be made by the engineer with the approval of the Joint Board of Commissioners.

Meagre Plans

The plan was merely a sketch showing the piers and abutments outlined, and the work could not have been built in that way. The chief engineer, who, by the way, was not the engineer who made the contract plans, made up detail plans, showing pier 4 on piles on a wooden grillage, 40 feet below low water. The work was built according to these detailed plans, was accepted and paid for in full.

A year later Pier 4 settled 15 inches in one jump, and at one time it looked as if the whole bridge was going down. We were asked to investigate the trouble, and found that the teredo, a water bug, had eaten off the piles in this pier and had allowed the pier to settle into the river bed, which fortunately was hard material. Of course, this raised a row, and as the engineer had died, the commission disbanded, and the engineering force dismissed, there was no one left to hold responsible but the poor contractors.

We, however, proved an "alibi," as far as actual construction went, but the legal question was brought up, that these plans, particularly of Pier 4, which had settled, had never been approved by the Joint Board; that is, the records of the Board did not show any action whatever on this pier. We were sued for $300,000, but the case was never tried, and has since been abandoned.

But here, we accepted working plans from the engineer, executed them under his direction and to his satisfaction, finished the bridge, which was accepted and paid for, and yet we were held liable for loss arising later, solely because the engineer did not get his plans approved. That is, a contractor accepts plans and orders from the engineer, does work according to his plans, all without question, in good faith on both sides, with the belief that the engineer has authority for his plans and orders, and that on his certificate he will be paid for all the work done under it; and yet in a lawsuit the contractor cannot recover if the engineer has exceeded his authority.

Plans Should be Approved

So you engineers to protect yourselves, and not do unwittingly a great injustice, should protect the contractor, by getting plans and orders approved, when

so required by the contract, because most contractors will never ask the question as to your authority.

You will say again, in public lettings, we have to award our contracts to the lowest bidders who can furnish the bond required, that politics will control this, and to save yourselves trouble and annoyance you cannot avoid letting the low bidder get the work.

It is rather remarkable how many influential and public minded citizens will be found ready to plead for some "bum" contractor, and how little interest these same citizens show when the trouble comes to the engineer and financial loss to the city, through failure of this same "bum" contractor to finish his work. Here is a chance for engineers to do good work in civic reform.

It would seem from the decisions of the courts that most of the clauses which the writer has quoted as being onerous and unjust are outside the pale of the laws anyway; so why need they be put in contracts at this enlightened stage of the world's progress? I do not think you engineers are responsible for most of them, and their only accomplishment to-day is that they furnish a club to scare some poor contractor who, when shown the clauses in his contract, which may be sacred to him as something he has agreed to do, dares not, or cannot afford to fight for his rights, and so compel him to make an unjust, losing settlement of his claims.

But contractors are changing, as has been before stated, and the strong and able men who to-day are doing the great works, who are willing and ready to fulfill every part of their agreement, are going to demand of the principals for whom they work, a like complete fulfilment of their part of the contract.

City and commission engineers often hold back payments, do not make up their estimates, particularly finals, because, they say, they have not time or men to do it. How long would they listen to us if we made the same excuse—a lack of time or men in carrying on our work?

Still another clause, almost a universal one in contracts, that providing that the decision of the engineer shall be final and binding on both parties.

Extra Work

Some engineers think extra work is a clear "bonanza" for the contractor, but let me give you a few inside facts and figures. A very careful cost account on a reservoir job in New England showed a general expense item of 12.9 per cent. of the whole contract. This general expense included superintendence and miscellaneous general labor, insurance, including bond, freight and teaming plant, general office expense (field work), timekeepers, storekeepers, blacksmiths and watchmen.

On five jobs done by us, amounting to three million dollars' worth of work, the general force was 10.1 per cent. of the pay roll.

So we start with the direct cost of work, including labor and material, add to that 10 per cent. of the payroll for general expense, 5 per cent. of the pay roll for the use of small tools; also a proper charge for wear and tear of heavy plant; and then in the sum of all these you get the actual gross cost of the contractor of extra work.

Now you generous engineers allow us 15 per cent. of the actual cost of work, which includes insurance, a proper allowance for superintendent, watchman and timekeeper, and a reasonable rental for large plant. If there is a lot of material used and plant required, extra work may pay the contractor, but if only labor is used, with no plant, the less extra work done the better off we contractors will be.

But the above quoted clause is a generous one and consequently is seldom used, most contracts providing for only 10 per cent. profit, often not allowing insurance as a cost, and no allowance for tools, superintendence, or plant. Under such a clause extra work is done at great loss.

You engineers, some of you, will say, that argument is weak, that we have to pay a superintendent, watchman, etc., anyway, that our plant will be standing idle and may better be used; and so our claim for a proportion of general expense and bills is not well founded. That claim is similar to those sometimes made about railroads—the locomotive and cars are going to make the trip anyway, and it won't cost the railroad company any more to carry a man or two along; but somehow this argument won't work with the conductor, and we either pay or walk.

No Need for Trouble

In the opinion of the writer, there is no occasion for the general trouble and rows over extra work. A good contract provides that the contractor must get a written order for extra work, must show his pay rolls and vouchers and give all information as to these items, and it only needs a little business sense to get daily reports as to material used, and to daily check up the labor items; and then the disputes cannot get far.

It would seem possible for the engineer to keep as accurate cost of these items as the contractor can, and by getting daily checks on pay roll and material, it would not seem possible to have any considerable discussion. The trouble comes generally from not agreeing upon these items as the work is done; and after months, when the facts are forgotten and one party, generally the engineer, has lost his notes, it is difficult to get the true facts as a basis of settlement.

As a contractor, I must admit that many times extra bills are presented, and often paid, which are simply extortions.

On large public works there are generally engineers and timekeepers enough to keep track closely of extra work, and if they check up with the contractor all goes well. But the public service corporations and other interests, having no political offices to fill, do not have men enough to check up these items, sometimes not knowing that a contractor considers work "extra," and so there being no check on the contractor, extortionate bills are rendered and a row ensues.

Such cases as these make the trouble—their fame spreads, and consequently all engineers, public boards and owners, try to avoid extra work.

But it cannot be avoided. No plans or specifications of large contracts can be made definite and complete enough to cover the emergencies which make changes necessary.

Make Contracts Explicit

So make your contracts explicit in defining just how extra work shall be done; always by written order, so that you may know that the work is considered "extra" by the contractor; what shall be included in the cost, how checked up or accounted for, and how paid for.

Then make a reasonable allowance for profit, and it would seem that under these conditions "extra work" could be disposed of to the satisfaction of both parties.

Every unnecessary or unfair clause in a specification has its part in limiting competition and in lower-

ing the standard of honesty among contractors. A clause that may be used as a club can be avoided in one of two ways—either by not bidding on work governed by the clause or by using graft to insure that it shall be a dead letter.

As to the question of specifications, there is not much to say. They should also be exact and definite and free from clauses which may be interpreted in two or more ways, as for instance:—

"Piles shall not be less than 20 feet in length, 6 inches at tip and 10 inches at butt." We contractors understand this to mean that no pile longer than 20 feet nor larger than 10 inches at the butt and 6 inches at the tip can be required; while the writer knows of one case where the engineer required piles of longer lengths, on the theory that all piles must exceed 20 feet in length.

Again, "stone shall be from one quarry, shall be uniform in color, and shall show no sap or streaks." This was claimed by a contractor to mean that the stone should be from one quarry, that no single stone should show sap or streaks, but should be uniform in color. The engineer claimed that all the stone in the work should be from one quarry and should all be the same color, with no sap or streaks.

In a contract we executed, of about a million dollars, the writer had some serious discussion with the engineers, because they used general clauses in specifications, but when we came to do the work, brought out details of specifications which required special requirements. For instance: "coarse sharp sand shall be used." Later in the work special requirements as to fineness were wanted. Again, "cements shall be of a well established brand, shall be subject to rigorous tests of such character as the engineer shall determine." Later, a requirement as to chemical analysis was made, requiring cement that did not have exceeding 1½ per cent. of sulphuric acid. As we had contracted for Lehigh cement, and as it exceeded the sulphuric acid limit, and the price had gone up, we objected, and finally were told to get as near 1½ per cent. as possible.

Again: "The loam furnished shall be good, rich, black loam, free from gravel, stones and roots, and shall be satisfactory to the engineer." Later, loam was required which contained 8 or 10 per cent. vegetable matter.

Should not such difficulties as these be avoided by simply putting in the specifications these special requirements, and trouble avoided later when an attempt is made to read them in?

Accuracy Required

We contractors ask you to make your specifications definite and exact, and later want you to give us some leeway in enforcing them. We admit you cannot say "about" so much or so many, and yet ask you to interpret the clauses in that way.

It is reasonable to assume that most contractors contract for material in accordance with the specifications, and that the trouble comes to them in the delay of the work in waiting for new stock.

The worst trouble comes from stone. Much of it comes from a distance, is cut special, may come in large lots by vessel, with very difficult land connections, or vice versa. Stone is hard, to cut it properly requires great skill, with many chances for some small accident in breaking a joint or a corner. So when your inspectors condemn a stone because a small corner is gone, a joint a hair too wide, some slight discoloration on the face, a dog hole or a plug hole, and it means shutting down the job on that particular piece of work for two or three weeks, we naturally "kick," and we doubly kick if this stone happens to be out of sight, under ground or water.

Again, take the matter of piles, especially very long ones. In New England, such piles come from the South, Norfolk or thereabout, and come by rail on two or three cars. To replace one or two means a tremendous expense and delay—the cost of the single stick, and the tremendous freight charges for it.

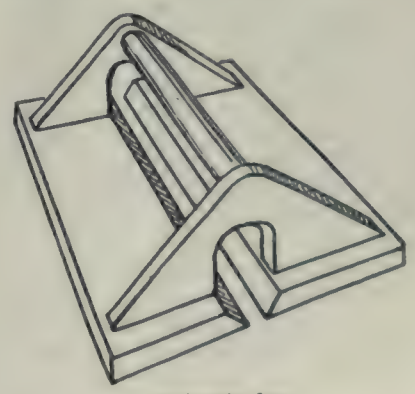
These two items and timber are the cause of most of our troubles, and that often due to irresponsible men who actually cut the stone or the farmers who cut the piles, as neither appreciate the idea of exactness.

If a contractor, bidding on public works to-day, ever tries to figure on all the chances which may come up, he never will get any contracts. He has to run the risks, to trust that some things will come his way, enough to balance the things that go against him. He doesn't want to be always kicking, making claims for extras, for small things, in the hope that the engineer will give him the benefit in doubtful cases, and such advantages as the work may offer, enough to offset his little extras. But when he doesn't get any of these benefits, especially if he feels that the engineer is wilfully withholding them, is compelling him to do the work to the extra letter of the specifications, where such exact work is of no value to anyone, when he is, in the common term of the profession, "getting roasted," then comes trouble, claims for extras, kicks and general eruptions.

To give and to take, to do justice on the one hand and good honest work on the other, and settle the difference man to man. Then lawyers will go out of our lives, the courts will be left for trust cases and divorce suits, and the day will come of good-fellowship and regard which should exist between the creators and makers of this modern world—the Engineer and the Contractor.

Split Float for Concrete Roads

To eliminate any shock or jar at expansion joints in concrete highways, recent practice has adopted the use of a joint filler. This filler usually consists of



A simple split float.

a strip of asphaltic felt, about one-quarter inch thick and sufficiently wide to extend completely through the concrete and stick up above the pavement preventing it from ironing down under traffic and completely filling the joint.

By the use of a split float such as shown, workmen may float the surface up flush with the filler and keep both sides at the same elevation, thereby eliminating any jar or tendency of heavy vehicles to crush the edge of the concrete, a condition which is often experienced when the joint is not filled.

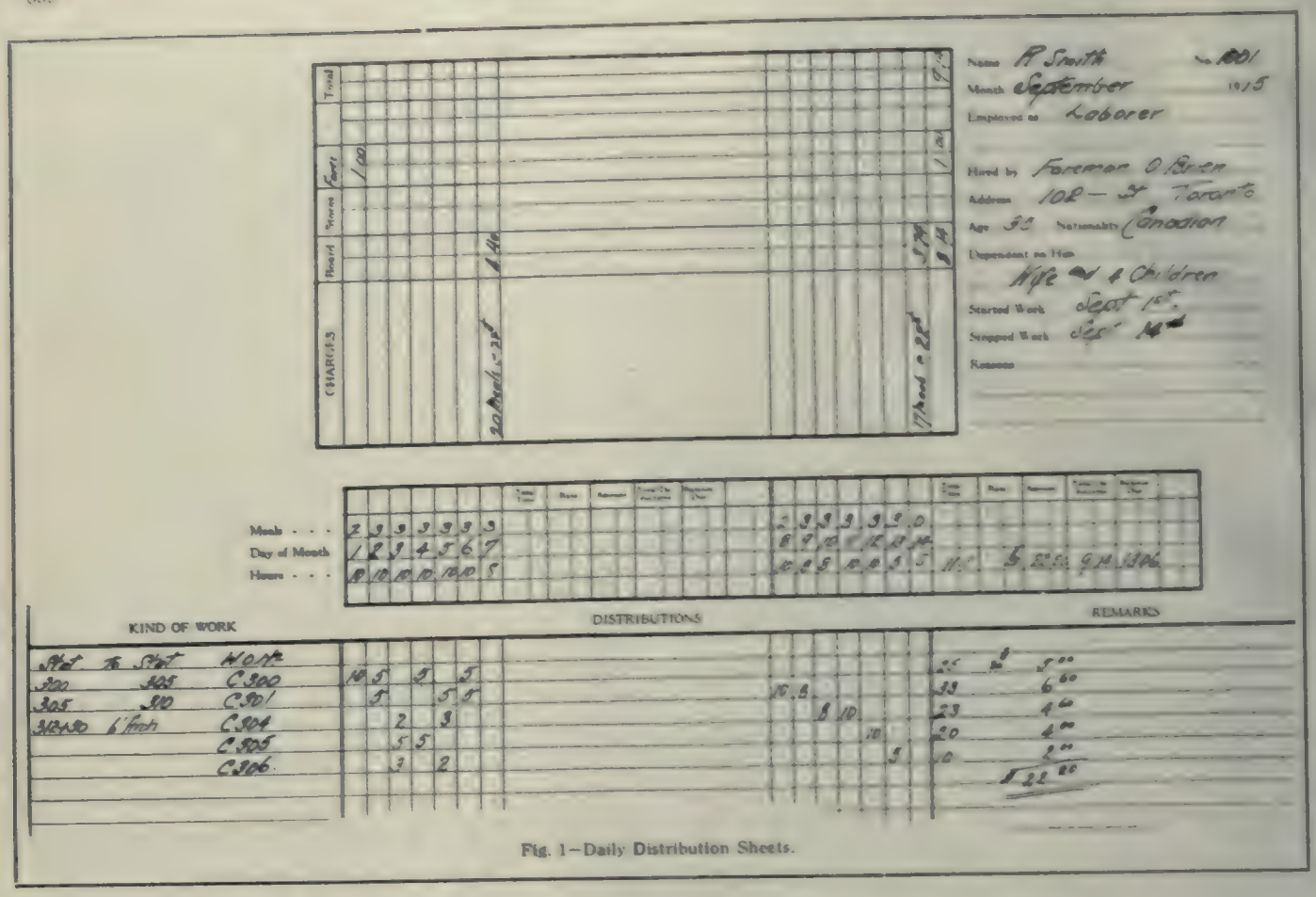


Fig. 1—Daily Distribution Sheets.

System of Cost Keeping Used on Toronto-Hamilton Highway Work

By R. T. Bell

As a natural result of increased competition the contractor of to-day finds it necessary to pay far greater attention to costs and cost keeping than heretofore, and various systems have been devised for this purpose. As being of interest to Contract Record readers, the following details of the cost system as put in use on the Toronto-Hamilton Highway by the writer are given. This system lends itself to amplification and extension, and can be adapted to all classes of construction.

The sheet, as shown in Fig. 1, is entered daily by the timekeeper at the close of the day's work, and carries full details of time, rate, charges, etc., as well as an hourly distribution under the different headings covering the class of work done; the number of headings depending upon the class of work and the amount of detail required. The headings on the Toronto-Hamilton Highway were all carried under work order numbers, sub-divided according to necessity, general headings being carried under initial letters, as:—

A, head office expense; B, engineering; C, construction. These initial headings were combined with figures, as: A. 100; B. 200; C. 300; thus giving one hundred sub-divisions to each general heading, and preventing the possibility of duplication of numbers. Examples are: C. 304, concrete culverts; C. 305, culvert forms; C. 306, reinforcement.

Should it be found necessary to exceed one hundred sub-divisions, then a small initial letter may be added as C. 300a., etc.

The work was divided into sections, each timekeeper having under him as many as 125 men. In some cases it was found necessary on account of the

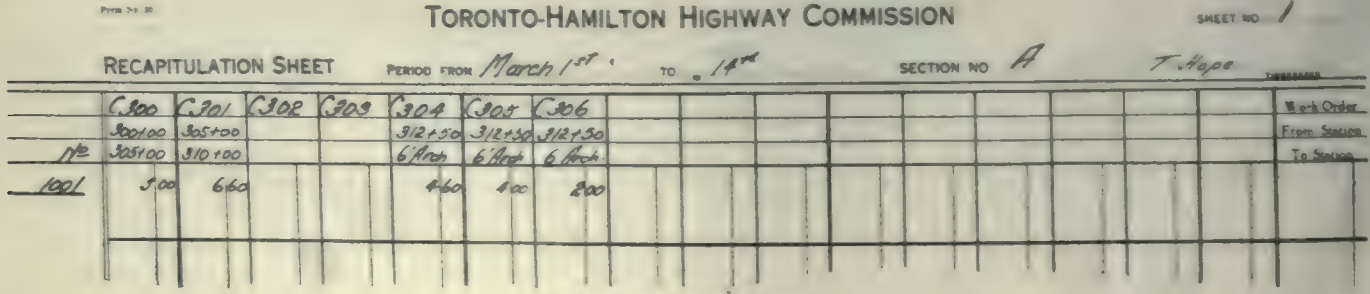


Fig. 2—Recapitulation Sheet.

TORONTO-HAMILTON HIGHWAY COMMISSION

SHEET NO 1-1

FINAL RECAPITULATION SHEET

Summary

SECTION NO. "A"

1915 PERIOD FROM	TO	C-100	C-200	C-300	C-400	C-500	C-600	C-700	C-800	C-900	C-1000				Work Order From Station To Station
Totals	to Feb 28	1223 37	1691 57				425 20	1217 24	18 78						19802 46
Mar 1st	Mar 31st	362 [illegible]	404 76				108 85	518 46	22 63						5058 08
Totals to	Mar 31st	1585 75	2096 63				534 05	1735 70	41 41						24860 54
April 1st	April 15th	210 92	2316 39				96 80	224 24	11 52						2859 87
" 16th	" 30th	175 64	2173 51			81 68	84 50	254 33	7 88						2779 74
Total to	April 30th	1985 31	2545 53			81 68	715 35	2214 27	60 01						30500 15
May 1st	May 15th	183 66	2194 38			13 44	69 96	240 16	94 98						2996 58

Fig. 3—Final Recapitulation Sheet.

number of different classes of work being carried on at the same time to have an assistant timekeeper. Pay-roll periods were semi-monthly, the daily distribution sheets being extended at the close of this period and serving as a check against the pay-rolls.

Details from the daily distribution sheets were then entered on the Recapitulation Sheet, as shown in Fig. 2 by the timekeeper and made out in triplicate, two copies of which were sent to the Division Office, where a final Recapitulation Sheet, Fig. 3, was made out by the cost accountant, whose duty it was to check all pay-rolls and recapitulations, and to visit from time to time the different timekeepers to ensure unity of methods.

Copies of the Recapitulation Sheet, Fig. 2, and the final recapitulation, Fig. 3, together with pay-rolls, were forwarded to the head office, thus giving them full details half monthly of the labor charges against each individual piece of work and a summarized statement under the initial headings.

This system proved invaluable both in settling disputes and making charges against the different municipalities and property holders for whom special work was done.

New Water Supply for Small Town Involves Earth Dam, Filters and Pipe Line

By James P. Wells*

AFTER suffering for 20 years from an inadequate supply of impure, hard well water, the village of Le Roy, N.Y., two months ago placed in service its new gravity system, comprising an earth dam 500 feet long and 32 feet high, a 1,000,000 gal. per day mechanical filtration plant and a 14 inch cast iron pipe line 5 miles long, laid in record time. Before the new system was placed in operation the consumption of water in Le Roy averaged only 200,000 gallons per day. As the old supply, on account of its hardness, was used very little for washing and factory purposes, it was estimated that with the new supply of soft water the consumption would reach 400,000 gallons per day, or about 100 gallons per capita. From data as to past growth, it is estimated that in 35 years the population would increase to 7,000 and that a supply of 700,000 gallons per day would be sufficient. Estimates were made and an appropriation of $105,000 was made for the construction of the new system, with $15,000 for extensions and improvements to the distribution system. Work was started in September, 1915, and in the fore part of April, 1916, the water was turned into the mains.

The reservoir has a capacity of about 175,000,000 gallons. Eighty-three per cent. of this amount, 145,000,000 gallons, is in the upper 14 feet and is available for use. The reservoir was formed by the construction of two earthen dikes and an earthen dam with a concrete core, and has an area of 55 acres when full.

Minimum Run-off Estimated

Mad Creek, the stream upon which the dam has been constructed, has a drainage area slightly in excess of 1½ square miles. From records of adjacent streams It was estimated that in an extreme low year the average daily run-off for the entire year would be at least 900,000 gallons per day. The run-off during the early part of the year is sufficient to keep the reservoir filled until the latter part of May or June. As there is occasionally a year when the run-off is very slight during the last six months, it was considered advisable, even though there is always some run-off, to construct a reservoir of sufficient capacity to furnish 700,000 gallons per day for six months without its being replenished by any inflow. This amount of water is equivalent to 126,000,000 gallons. The reservoir was accordingly designed to have a capacity of 145,000,000 gallons, a liberal amount being allowed for evaporation and seepage. At the time of writing the reservoir is full and overflowing and enough water has wasted over the spillway to refill it.

Earth Dam and Dikes

Test pits at the site of the dam indicated that an earth structure with a concrete core would be much cheaper than either a concrete masonry or a reinforced concrete dam of the Ambursen type. The bed of the reservoir is composed of a heavy, clayey soil. This is underlaid by shale rock. At the central portion of this dam this rock is 16 feet below the surface. At both ends of the structure no sheeting was necessary for the core wall trench, as the material was stiff clay and hardpan. At the centre of the dam considerable water was encountered. The material was sandy clay, and great difficulty was experienced in deepening the trench, it being necessary to work day and night. The core was carried to the rock for the entire central portion of the dam.

The greater portion of the material for the earth fill was excavated by an elevating grader loading di-

* Consulting Engineer, Rochester, N. Y., in Engineering Record.

rectly into dump wagons from a barrow pit just east of the reservoir. The remainder was placed by wheel scrapers. On the upstream portion of the structure fine, clayey material was deposited in 6-inch layers. This was then watered and rolled with a 2-ton, grooved roller. The coarser and more porous material was used on the downstream side. The width of the dam is 10 feet at the top with an up-stream slope of 3 to 1 and a downstream slope of 2 to 1. Severe winter weather set in before the work was completed so that it was necessary to leave the work when the embankment had been carried to the top of the core, 3 feet above the crest of the spillway. Although the wetting and rolling of the embankment was materially aided by considerable rainfall during the construction there was some settlement when the water reached its full height. Riprap, 1 ft. thick, was placed on the upsteam face of the dam to a depth of 14 feet below the spillway crest, the point of lowest draft. The earth dikes in no case exceeded a height of 9 feet, and as their crest is 5 feet above the normal water level they were made 5 feet wide at the top, with 2 to 1 slopes on each side.

The concrete spillway was designed with a width of 60 feet at the point of overflow. Its crest is 5 feet below the surface of the dam. For the size of the stream a spillway width of 60 feet is perhaps somewhat greater than is ordinarily allowed, especially with a reservoir area of 55 acres, which will temporarily store a large amount of water and greatly decrease the intensity of a flood. However, in the light of the recent flood at Erie, where the flood rate was about 900 sec.-ft. per square mile from a stream with a drainage area ten times the size of Mad Creek, it is evident that such a spillway width is not too great.

Concerte

The concrete in the core was of the proportion 1:3:6; that in the spillway, 1:2½:5. The gravel was obtained from a pit ¾ mile east of the works. The location of the spillway, core wall and filter plant was such that considerable economy could be effected in the placing of the concrete. An 18-cu.-ft. Koehring mixer was placed at each end of the core wall. Practically all the concrete, not only in the core wall but in the spillway and filter plant, was poured from these mixers through open chutes without changing their position.

Filtration Plant

Water passes from the reservoir into the filter plant through a 16-in. cast iron pipe. Before entering the sedimentation basin it is aerated by a fountain in a small building attached to the filter house. After aeration the water descends through a Venturi tube into the sedimentation basin. The Venturi tube was installed to automatically regulate the flow of chemicals. Up to the present time it has been found necessary to use only sulphate of alumina. There are two beds in the plant, each with a normal capacity of 500,000 gallons.

Leading from the clear well of the filter plant is a 14-in. cast iron pipe, which carries the water to the village. Remarkable progress was made in its construction. With the exception of 100 feet of hard limestone rock in the lower portion of the trench the entire 24,500 feet was excavated with an Austin trenching machine. Of this amount 500 feet extended through shale rock, 3 feet of which occurred in the bottom of the trench. There were also 700 feet of woods. The first 22,000 feet of the line, which included the sections of rock and woods, was completed, including the back-fill, in 35 days, an average of 750 feet per day. The greatest amount of trench excavated during any one day was slightly over 1,000 feet and the record for laying pipe was eighty-five 12-ft. lengths. This record is not often excelled and it was made possible by the efficient manner in which the contractor handled the work.

In order to increase the supply of water available for fire protection purposes an elevated tank with a capacity, when full, of 130,000 gallons, has been constructed, in addition to the old stand-pipe. There is sufficient pressure from the new system to raise the water above the top of the old stand-pipe, but in case of a large fire there would be considerable head lost in friction from the reservoir to the point of the fire. For this reason it was considered advisable to have more water available directly at the distribution system. In addition to this several dead ends will be connected, which will greatly improve the fire protection in the factory district.

Large Water Powers of Northern B. C.

By T. C. Duncan, Mem. A.I.E.E.

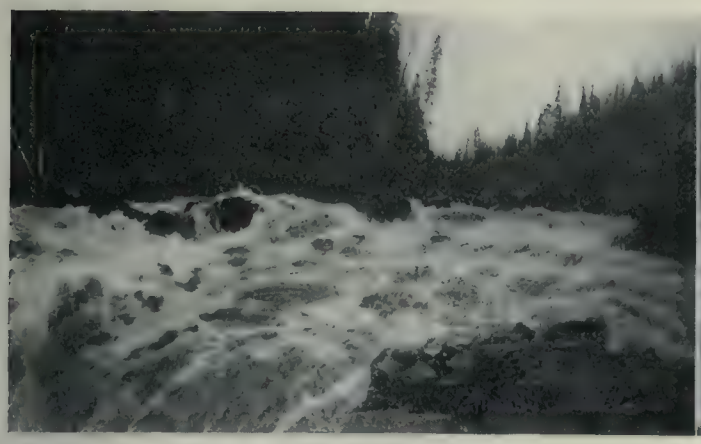
Within the last few years a great deal has been published on the water powers of British Columbia. With the exception of the Prince Rupert Hydro-Electric Company's undertakings, the subject has been treated only in a general way, at least in what is known as Northern British Columbia. The Government of British Columbia has spent considerable sums of money collecting data on the water powers of the southern part of the province and have published a very successful and interesting book on the subject. The investigations, however, have so far been limited to Southern British Columbia. I am not in a position to give information regarding the water powers of the northern district in the complete form that the Government has covered the southern part; but I propose mentioning some of the streams which have prospects of development within the near future in connection with the mining industry of this district.

To begin with, at a point about 120 miles south of Prince Rupert, on Princess Royal Island, the Belmont-Tonapah Mining Company are now building a dam and have the plant on order for developing 1,000 kv.a. of electric power for use in the development of their mining property 7½ miles distant. The plant is to consist of two 900 h.p. low head turbines and two 500 kv.a. generators.

Travelling north along the coast in what is called the Inside Passage, numerous inlets extend far back into the coast range of mountains, and all of these inlets have streams flowing into them which are suitable for hydro-electric development of a more or less extent. While this country is not yet opened up, it is in the line of the coast mineral belt and undoubtedly will be developed as more money comes into the district.

On the Skeena River

When we reach the Skeena River, we find two large water powers, on the Osctall and Khatada rivers, which have been held by the Prince Rupert Hydro-Electric Company and undoubtedly have been well ex-



Nass River, Northern B. C.—First Falls.

Nass River, Northern B. C.—Second Falls.

ploited. Unfortunately, the war put a temporary damper on the development of these powers, because they were depending on Prince Rupert's development for their market. The city of Prince Rupert is now operating a plant of 1125 kv.a., situated on a small stream 5½ miles from the city. This, hawever, is only a start in the hydro-electric development of the city. They have a power on Thume River in the North Arm of Work Canal, which is large enough to produce power up to 30,000 h.p., and which can be developed at a very low cost. The machinery can be landed on the power house site from the slings of coastal boats and the pipe line will only be about 1,000 feet long. Within two and a half miles from this power and flowing into the opposite side of the Arm is another power of even greater size, but more expensive to develop. The mineral belt is less than 20 miles from these powers and although there are plenty of small powers close to the mineral belt these larger powers may be developed to supply the surrounding country.

Syndicate Holds Nass River

A little to the north of this inlet the Nass River empties into the Pacific and on this river a Winnipeg syndicate holds the water rights of one of the biggest water powers in the country. Two views of this power are shown herewith. This power is in close proximity to the coal district known as the Groundhog Country, and through which the proposed new road to Alaska is destined to pass, and also the road now under construction from the Peace River through the Omineca country to the coast. This Nass River power is of such capacity that when the time comes for electrifying the railroads of this northern country the power is there and well located for distribution.

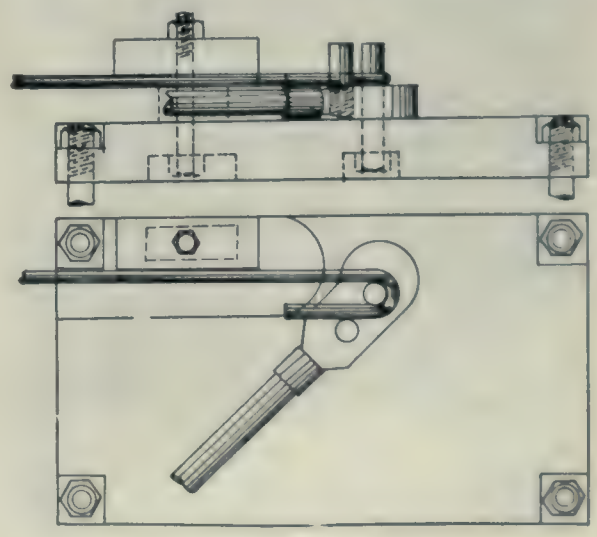
Leaving the Nass River country and coming back to the coast into the Portland Canal district, we enter a rich section of the mineral belt and a possible field of hydro-electric development on a smaller scale. The Granby Mining and Smelting Company are now operating a hydro-electric plant, which, of course, is well known to the outside world. A new camp has been started at the head of Alice Arm, an inlet about 15 miles from Anyox, the Granby headquarters. There are three properties working in this district now. One of them is building 18 miles of road from the salt water to their mine at the present time, and building a road in this country is no light undertaking. Within a radius of four miles from the head of this arm there are four small high head water powers and one fairly large one. The large one has been taken up by the owners of a group of mineral claims which take in the power house site, These claims will not require all the available power for their own working and they are negotiating with Southern capital in connection with a transfer of their rights. In conversation with one of the principals of the Southern company recently, I was told that their intention was to develop power enough to supply the town and other mines in the inlet as well as their own property which is being opened up.

A Prime Factor in Development

While quite a number of powers have been mentioned, I have picked out only a few which have prospects of being utilized within the near future. This northern country is undoubtedly on the eve of a substantial development, and in that development the water powers will be a prime factor. At present many of the schemes seem visionary, but one by one they will come to pass and the country will reap the full benefit of its great heritage.

Rod Bender

The cut shows a handy device of simple construction for bending reinforcing bars to be used in concrete work. It consists of a cast iron or heavy hardwood base which can be securely bolted to some solid



Handy Rod Bender.

foundation, an adjustable block, and a lever with two heavy iron blocks. Bars up to 1 in. or 1¼ in. diameter can be bent cold on such a machine. Contractors who have a job requiring the bending of a considerable number of rods will find such a device useful.

Trusts and Guarantee Co.'s Building

The illustration herewith shows the proposed new office building of the Trusts and Guarantee Co., Ltd., Bay Street, as it will appear when complete, and for which excavation has already started. At present, only seven stories and basement will be built, provision being made for the addition of four more storeys when required. In plan, the building measures 50 ft.

Trusts and Guarantee Building.

x 95 ft., and it will be constructed with a steel frame and stone, terra cotta and brick filling. The front will be of Indiana limestone on a Stanstead granite base. The building will be equipped in the most modern manner adapted for office buildings. The first three floors will be occupied by the Trusts & Guarantee Co., the main or banking floor being furnished in Tavernelle marble, with a clear space unobstructed by any columns. The remaining floors will be rented as offices.

Curry & Sparling, Bond Street, Toronto, are the architects. The estimated cost is about $200,000.

Letter to the Editor

New York, June 23, 1916.

Editor Contract Record:

We have read with considerable interest your valuable and timely article on "Dry Rot Menace in Factory Timbers," in your issue of May 17. In discussing the available methods of preservative treatment you state "increased fire hazard, resistance to paint and a disagreeable odor are items to be considered . . . for this reason the numerous creosote and tar compounds are often unsuitable." The writer, who has followed very closely the discussion on this subject for some years, begs to take exception to some of these conclusions.

With reference to increased fire hazard, the general consensus of opinion is that creosoted timber, except for the first few weeks after treatment, is not more readily ignited than untreated timber, and that after a time the effect of the creosoting treatment is to retard combustion. This statement can be confirmed by reference to the Proceedings of the American Wood Preservers' Association, American Railway Engineering Association, and the National Electric Light Association.

With reference to the odor of creosoted timber, only in exceptional cases is this at all objectionable in a factory building, the best proof of this being the widespread and general acceptance of the creosoted wood block floor in modern factories and warehouses (the Curtis Publishing Co.'s establishment in Philadelphia being a striking example.)

It is true that creosoted timber tends to discolor paint, especially the lighter shades. However, in the majority of instances the use of paint over treated timber is not considered necessary. It is also true that timbers treated with metallic salts will not hold paint well, as the paint tends to crack and peel off.

Yours truly,
The Barrett Company,
S. R. Church, Manager, Research Dept.

Montreal Aqueduct Work to Proceed

The Montreal aqueduct scheme, including the hydro-electric development, is to proceed, the Council having agreed to this by 13 to 6. A deputation from the Canadian Society of Civil Engineers, the Board of Trade, and the Canadian Manufacturers' Association, headed by Sir John Kennedy, appealed to the aldermen to appoint an independent board of engineers to examine the plans, but as appeared at a subsequent council meeting, the appeal was without effect. Controller Ross stated that three members of the board had supported the proposal of engaging outside advice to re-examine the plans, but as the board could not agree on the choice of engineers, the matter had fallen through.

The Constructors, Limited, manufacturing contractors, Regina, have the following work in hand: alterations and additions to the Regina General Hospital; residence in Outlook, Sask., for J. W. Fraser, and residence on Stuart Street, Regina.

Suggested Standard Symbols for Architects in Designating Electrical Layout of Buildings

(4) Ceiling Outlet; Electric only. Numeral in centre indicates number of Standard 16 C.P. Incandescent Lamps.

4/2 Ceiling Outlet; Combination. 4/2 indicates 4-16 C.P. Standard Incandescent Lamps and 2 Gas Burners. If gas only, circle all black.

(2) Bracket Outlet; Electric only. Numeral in centre indicates number of Standard 16 C.P. Incandescent Lamps.

4/2 Bracket Outlet; Combination. 4/2 indicates 4-16 C.P. Standard Incandescent Lamps and 2 Gas Burners. If gas only, circle all black.

[2] Wall or Baseboard Receptacle Outlet. Numeral in centre indicates number of Standard 16 C.P. Incandescent Lamps.

[4] Floor Outlet. Numeral in centre indicates number of Standard 16 C.P. Incandescent Lamps.

6 Outlet for Outdoor Standard or Pedestal; Electric only. Numeral indicates number of Standard 16 C.P. Incand't Lamps.

6/6 Outlet for Outdoor Standard or Pedestal Combination. 6/6 indicates 6-16 C.P. Standard Incand't Lamps; 6 Gas Burners.

(D) Drop Cord Outlet.

⊗ One Light Outlet, for Lamp Receptacle.

◑ Arc Lamp Outlet.

▲ Special Outlet, for Lighting, Heating and Power Current, as described in Specifications.

Ceiling Fan Outlet.

S^1 S. P. Switch Outlet.

S^2 D. P. Switch Outlet.

S^3 3-Way Switch Outlet.

S^4 4-Way Switch Outlet.

S^D Automatic Door Switch Outlet.

S^E Electrolier Switch Outlet.

Show as many Symbols as there are Switches. Or in case of a very large group of Switches, indicate number of Switches by a Roman numeral, thus S^1 XII; meaning 12 Single Pole Switches.

Describe Type of Switch in Specifications, that is, Flush or Surface, Push Button or Snap.

Meter Outlet.

Distribution Panel.

Junction or Pull Box.

(5) Motor Outlet; Numeral in centre indicates Horse Power.

Motor Control Outlet.

Transformer.

Main or Feeder run concealed under floor.

Main or Feeder run concealed under Floor above.

Main or Feeder run exposed.

Branch Circuit run concealed under Floor.

Branch Circuit run concealed under Floor above.

Branch Circuit run exposed.

Pole Line.

Riser.

Telephone Outlet; Private Service.

Telephone Outlet; Public Service.

Bell Outlet.

Buzzer Outlet.

2 Push Button Outlet; Numeral indicates number of Pushes.

(8) Annunciator; Numeral indicates number of Points.

Speaking Tube.

(C) Watchman Clock Outlet.

Watchman Station Outlet.

(T.C.) Master Time Clock Outlet.

Secondary Time Clock Outlet.

Door Opener.

Special Outlet; for Signal Systems, as described in Specifications.

Battery Outlet.

Circuit for Clock, Telephone, Bell or other Service, run under Floor, concealed. Kind of Service wanted ascertained by Symbol to which line connects.

Circuit for Clock, Telephone, Bell or other Service, run under Floor above, concealed. Kind of Service wanted ascertained by Symbol to which line connects.

Heights of Centre of Wall Outlets (unless otherwise specified):

Living Rooms	5 ft. 6 ins.
Chambers	5 ft. 0 ins.
Offices	6 ft. 0 ins.
Corridors	6 ft. 3 ins.

Height of Switches (unless otherwise specified) 4 ft. 0 ins.

Hollow Steel-Concrete Floors

ONE of the comparatively recent improvements in the method of constructing concrete floors is the use of hollow tile. There are in use at present several designs of the hollow concrete system, on all of which patent rights are claimed. One of the most important developments which gives promise of extensive use and which offers many advantages is the steel "Floretyle," illustrated in this article.

The flat slab construction is perhaps the most popular of the reinforced concrete floor systems in present use. Its advantages in the elimination of beams and girders is apparent. It gives large stretches of flat ceiling suitable for a wide range of architectural effects, or it provides, in factories, scope for arranging shafting without interference, and further, the absence of projecting girders enables partitions to be placed in any desired position without regard to the beams overhead. On the other hand, solid concrete slabs become heavy and expensive for long spans, which means that secondary beams are required with decreased head room and a restriction in the placing of partitions. In addition, the centering for solid floors is expensive in that it requires a large amount of lumber.

These disadvantages have led to the use of hollow floors, the latest type of which employs steel floor tiles. Floor tiles are made as shown, finished in lengths of three or four feet and in depths of 6, 8, 10 and 12 inches. The width of the base is in all cases 21 inches, with the sides tapering. The floor consists of rows of this tile, with 4-in. spaces between the rows. These are covered on top with a thin layer of concrete and separated by reinforced concrete joists which carry the loads directly to the supports. The under side of the steel tile is covered with a metallic covering, and plastered to form a flat ceiling.

Hollow floors of this type possess many advantages. They permit long span construction without excessive dead weight and the cost is much lower than for solid floors. The deep joists permitted are also a factor of strength, for the stiffness or rigidity of a floor depends to a certain extent on the depth, and vibration to which thin floors are subject is largely eliminated.

The tile system simplifies to a very large extent the work of centering, and in this way minimizes the cost. With solid floors a close boarded centering is required, while for the hollow construction a board is needed only under each reinforced joist, and as these are 21 inches apart, considerable saving is entailed. The amount of timber is thus only about one-half that required for a solid slab. Hollow floors of steel tile can be constructed more quickly than the more conventional type on account of the lightness of the tile and its ease in setting up.

Not the least important point in regard to this material is its advantage when used with steel skeleton building. The light weight reduces the size of the members and the columns. The total load is reduced, bringing about a saving in the foundation bases. The sound-proof qualities of this floor, too, are enough to recommend it for a building where noise is objectionable.

The advantages accruing from the use of this new floor construction may be summed up in the following items: (1) The hollow steel tile floor is sound-proof; (2) long flat slabs can be made with low dead weight; (3) the low weight produces an economy in the structural frame work and in the column foundation; (4) internal partitions can be placed in any desired position; (5) the elimination of secondary beams increases head room; (6) much simpler centering is required than in the case of solid slab construction; (7) the amount of timber needed for centering is less than that required for solid floors; (8) hollow floors can be constructed more rapidly than solid floors; (9) the extra depth of the slab increases the rigidity of the building; (10) the cost is less

Combined Water and Sewage System

At a session of the Essex Border Public Utilities Commission, recently held at Windsor, Ont., it was announced that the commission had ratified the appointment of a board of engineers whose duty it was to prepare comprehensive plans for a joint sewage and water system for the six Canadian border municipalities, Windsor, Walkerville, Sandwich East, Sandwich West, Ford, and Ojibway, and when the plans are perfected the project will be submitted to the ratepayers. The approximate cost of such a system is estimated at between $1,500,000 and $2,000,000.

Invar

The American Bureau of Standards of the Department of Commerce, Washington, proposes to issue a series of circulars of information on the properties of the more interesting or technically important metals and alloys. The first of the series, describing the properties of the non-expansible alloy, "Invar," and other nickel steels, has just been issued. The magnetic electrical, thermal and mechanical properties are given, together with numerous illustrations, statements concerning micro-structure, constitution, applications and sources of supply.

Annual Report for Victoria City

The corporation of the city of Victoria, B.C. have issued in book form their annual report for the year ending Dec. 31, 1915. The report contains sections devoted to the following departments: accounting, legal, engineering (C. H. Rust, city engineer), waterworks (C. H. Rust, water commissioner), assessor, police, fire, electrical, library, market, stores, health, miscellaneous. The report covers 114 pages.

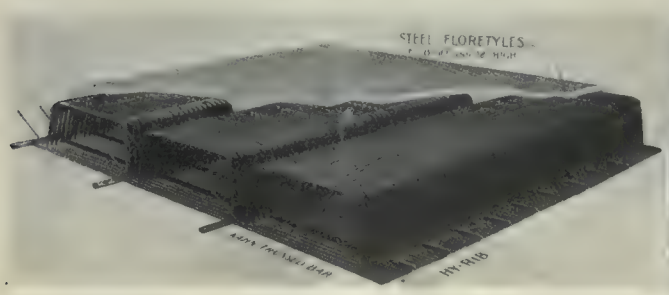


Fig. 1—Hollow concrete floor with steel tile

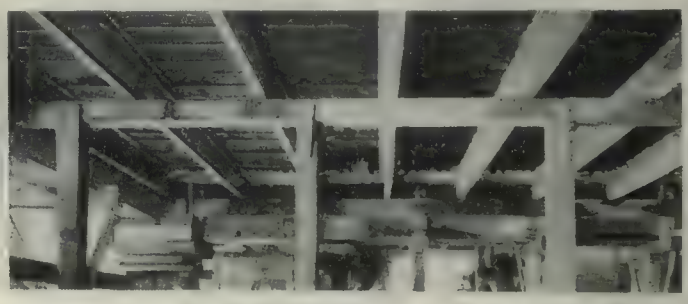


Fig. 2—Simple centering required.

Highway Improvements in Nova Scotia

Great Care Necessary in Road Maintenance—Numerous Illustrations of Culverts, an Important Factor in Road Making

THE annual report of the Highways Division of the Department of Public Works and Mines of Nova Scotia has just been issued. It includes the report of Mr. W. G. Yorston, C.E., Asst. Road Commissioner, on road and bridge construction and repair, and also a report on larger bridges and subsidized railways by Mr. Hiram Donkin, C.E., Provincial Government Engineer. Some illustrations from Mr. Yorston's report are reproduced below, with extracts from the report. In an early issue illustrations of the larger bridges will be shown.

Concrete Culvert 14 ft. Span. Greenfield Road, Queens Co.

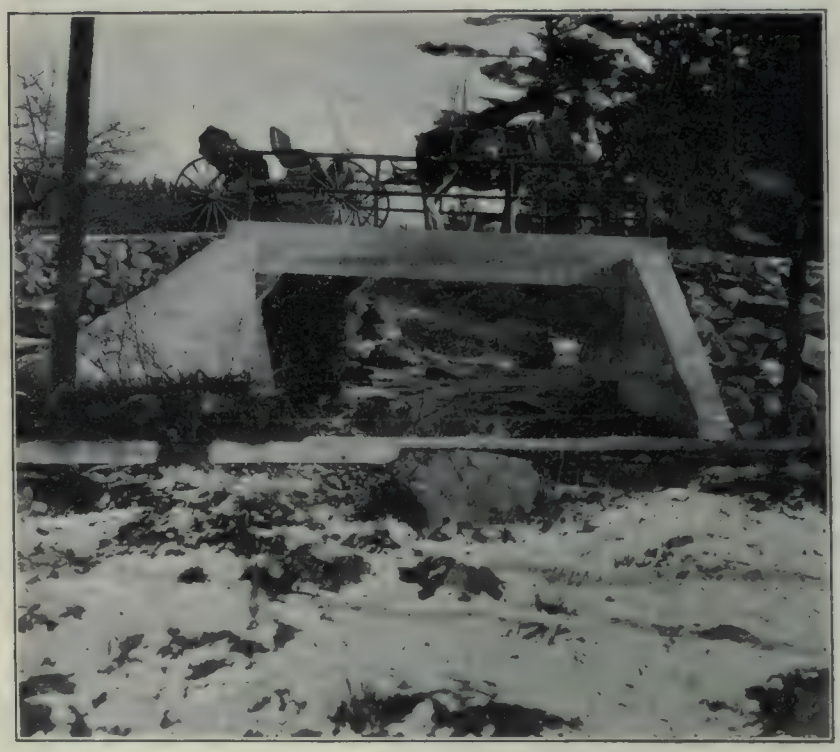
The expenditures made under the Highway Dept. during the fiscal year of 1915, are as follows:—Road appropriation for maintenance, $235,000.70; betterment of highways, $73,465.21; motor vehicles Act, road improvement fund, $9,022.20; construction of permanent materials, of smaller bridges and culverts in highways, $216,667.99; larger bridge construction, $82,536.91; total, $616,693.01. The total expenditure for the fiscal year of 1915 is nearly 20 per cent. in excess of the expenditure for the same period in 1914, the principal increase being under Chapter 26, Acts 1912, "Act respecting the construction, of permanent materials, of smaller bridges and culverts in public highways." The expenditure under the Act on Betterment of Highways is also much larger than for the previous year. There is also an increase in the road machinery equipment placed in use during 1915. There was a special demand for road graders, which have been very successfully employed in some of the most rocky and difficult parts of the province, and even in some of the counties where it was difficult to get teams to operate the graders, the machines proved more economical than any other method. The item of expenditure under the heading of "Roads," $235,000.70, includes an amount of $67,493.00 spent on the repair of larger bridges and on their painting. This reduces the actual sum spent on work to $167,507.70. Using the estimate of about 18,000 miles of highway in the province, this means that on an average $9.19 was spent per mile of road for the year. Either the nominal or real value of the statute labor applied to the roads in the different municipalities is almost impossible to determine. Based on the assessed value of property, there ought to be approximately $225,000, either in cash or commuted labor, or partly in one and partly in the other, so applied in addition to the annual appropriation made by the province. If this item were available in cash, it would average about $12.50 per mile. There are, however, very many sections throughout the province in which the statute labor is so indifferently applied as to be practically ineffective.

Concrete Culvert 8 ft. Span.—Road Bridgewater to New Dublin, Lunenburg Co.

It is estimated that there are 18,000 miles of railway in Nova Scotia, the

10 ft. Span Reinforced Concrete Slab on Granite Abutments.—Road Bridgewater to New Dublin, Lunenburg Co.

14 ft. Span Reinforced Concrete



14 ft. Span Culvert.—Caledonia Road, Queens Co.

Concrete Culvert, 14 ft.

ranite Abutments.—Lunenburg Co.

16 ft Span Reinforced Concrete Slab and Concrete Abutments. New Germany Road, Lunenburg Co.

eenfield Road, Queens Co.

Concrete Culvert, 8 ft. Span. New Germany Road, Lunenburg Co.

4 ft. Concrete Arch Culvert.—Riverport Road, Lunenburg Co.

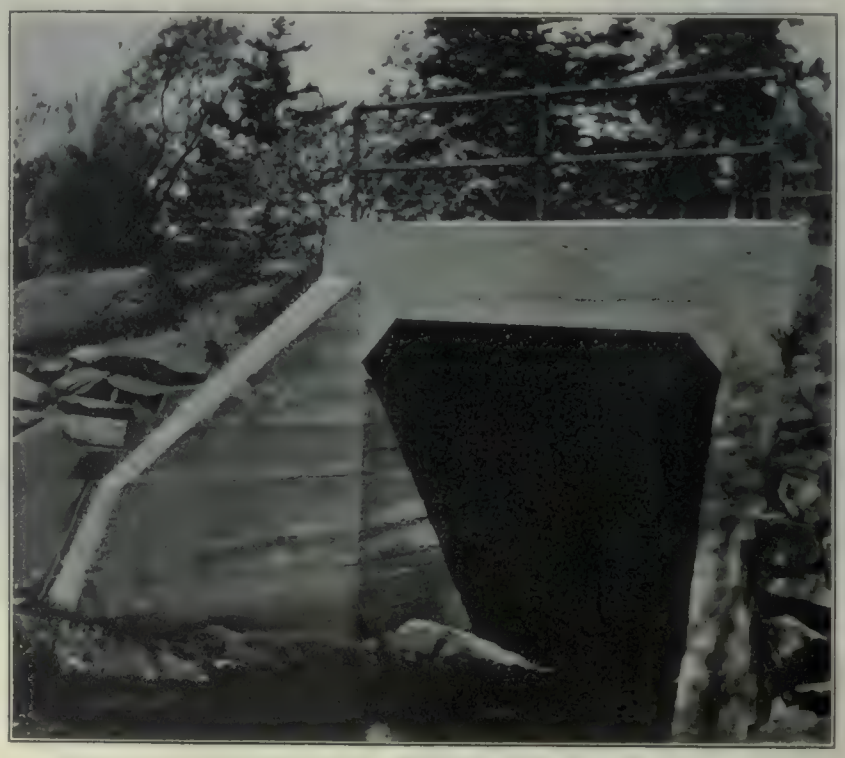
greatest part of which is not improved road, in that it has never been properly ditched, shaped and drained, and often has not even good wooden culverts.

If the roads through the province were properly drained and graded, with proper culverts, all the money provided annually could be expended in maintenance, and a fairly good showing could be made. The installation of culverts, as well as the road work done under the various acts of the Legislature, has done much to improve the conditions of the roads in the different counties and the roads so improved, although they will still require a sum for maintenance, will not need the same amount of annual expenditure as in former years where road expenditures have been made out of capital. On roads in which permanent culverts had already been built, the improvements are, of course, most marked, but even where culverts only have been installed, the ditching done to make the culverts effective has benefited the roads vastly and the expenditure out of revenue has been very much lessened.

The report emphasizes that the question of maintenance in Nova Scotia is a matter of the greatest importance, not only for future betterment, but to protect those highways upon which expenditures have already been made. Too often it has been found that a road has been neglected as soon as its construction was completed, but more definite schemes of maintenance are now being arranged. The ideal system would be to have a road patrol which would provide for the permanent employment of skilled laborers and caretakers, well accustomed to road work and repair. Each one of these patrol men would have charge of a particular section of highway. Of course, it would be impossible to adopt a patrol system everywhere throughout the country on account of the sparcity of population and the very limited resources, but there are many communities in which a patrol system might be used with much benefit. This system has already been applied to some extent to the roads of Nova Scotia and an extension is soon hoped for.

The Commissioner points out the very serious injury done to many of the highways of the province by the use of narrow tires on heavily loaded vehicles. The injury to the roads occasioned by the continued use of narrow tires on such vehicles requires annually the expenditure of a large amount of money to repair the highways on which they are used. It is pleasing to note that there is a growing appreciation on the part of the public that some limitation should be put on the unnecessary damage thus caused, and the Nova Scotia Farmers' Association have passed a resolution recommending the Legislature "to enact a law that will, without undue expense to the farmer, gradually introduce the wide tires on all vehicles capable of carrying over one ton weight."

The expenditure made under Chapter 26, Acts 1912, "An Act respecting the construction of permanent materials, of smaller bridges and culverts in public highways," during the fiscal year of 1915, has been by far the largest yet made, being nearly double the expenditure in the previous year. The total amount was $216,667.99. There was a considerable increase in the amount of day work done under this act. By constructing the culverts by a system of day labor it was found possible in several instances to have culverts done simultaneously with road improvements under other Acts. Construction by day work



Savary Culvert, 8 ft. Span.—Barton, Digby Co.

also enabled the building of culverts where the tenders had previously proved unsatisfactory. During the year the quality of the work has been uniformly good and all contracts were fairly well prosecuted, although the very wet weather proved a great detriment to good progress. The amount spent on culvert construction by day labor was $47,368.72, being about one quarter of the value of the whole work done under this Act during the year, and it is stated that no improvement so far made on the roads of the province shows more value for the money expended than the permanent culverts built under this Act.

Expenditures totalling $73,465.21 were made under the "Act to Provide for the Betterment of Highways." The work done under this Act has in nearly every case been performed by labor obtained in the locality of the county in which the work was done. Necessarily the value of the work varies to a very considerable extent. The difficulty has been in procuring men to do the work, except at times best adapted to suit their own convenience. The farmers have kept workmen from doing work on the roads and this has had a tendency to delay much of the construction to a later time in the year. This has been a more or less decided disadvantage.

The ideal system would be to have all such work done by specially trained gangs. This is being carried out in some counties, but in some sections of the province the farmers find themselves too busy to permit men to work upon highways.

In all cases where road improvements were made under this Act, specifications were prepared in the Roads' Office, covering the method of executing the work. The work done in many cases has been of a very superior nature and is an object lesson to many who have seen or travelled over the stretch which has been improved. It has been impossible in all cases to surface the road after improvement with either gravel or stone, but it has been the aim in each case to provide permanent drainage as the first consideration and then, if possible, to have all the structures made permanent and the road surfaced. The essential point in road construction and one that is always insisted on is that thorough drainage shall first be accomplished and this has always to be done before other improvements are put on the roads.

Many improvements have been made to earth roads under this Act, where no surfacing material was available, but careful attention is required in these cases both spring and fall to keep the ditches from filling up and to have the surface of the road smooth and rounded to the shape it was given when improvements were made.

No expenditures for macadam roads were made during the fiscal year of 1915. Expenditures were authorized on short stretches of road, but no money was spent.

The result of the expenditures made under this Act have been the improvement of many bad stretches, and while the magnitude of the expenditures does not permit of very extensive work being done in any one locality, yet the improvements made are very marked. If the expenditure under the provisions of this Act were further extended it would result in a continuance of the betterments already effected. The work done under this Act in the various counties and the nature of the improvements effected will have, it is believed, a distinct influence towards bringing about better road work in the various districts, as the work serves as an object lesson.

The moneys appropriated under the "Motor Vehicle Act, Road Improvement Fund," have enabled the Roads Department to put in order many lengths of road which otherwise could not have been attended to. Many stretches of road remain on which similar sums could be expended to good advantage. The improvements effected with the moneys expended under this Act are very noticeable. It is thought that by expending money systematically on the main thoroughfares of automobile traffic, great betterment will result. The motor licenses collected and available for expenditure in 1915 amounted to $21,270.15.

Waterworks Operations in Stettler, Alta.

By Mr. H. Baron*

The town of Stettler is situated at the crossing of the C. P. Ry., Lacombe to Coronation branch, and the C. N. Ry., Vegreville to Calgary line, in the midst of what is perhaps the best mixed farming country in Alberta.

It is a typical prairie town of some 1,700 inhabitants, springing up about eight years ago. In September, 1911, the town started its own waterworks, having built a small pumping station within a short distance of the crossing of the C. P. and C. N. Rys.

This pumping station consisted of a deep well dug 4 ft. in diameter, and bricked in to 68 ft. deep, and then drilled with a 10 in. hole for 190 ft. further. At 68 ft. so much quicksand was found that a cement bottom had to be put into the well, and the 10 inch bore hole taken through it.

This was cased until rock was encountered when the casing was discontinued. Water is pumped from this well continuously into a reservoir of 50,000 gals. capacity, placed outside the power house, 32 ft. in diameter, and dug down 10 ft. into the earth. It is lined with concrete and has a wood roof.

From this reservoir the water is pumped by a duplex pump into the town mains and water tower. A horizontal return tubular boiler supplies the steam.

This boiler and pumping plant was supplied by the J. MacDougall Co., of Montreal. The boiler is 16 ft. x 72 in., working at 125 lbs. per sq. in., and rated according to Alberta Boiler Rules at 100 h.p. The duplex pump is of Worthington make, compound, and with cylinders 10 in. x 16 in., and 10½ in. x 10 in. This pump is designed to pump water from the reservoir into the water tower at 50 lbs. pressure for domestic supply, or in case of fire, when a higher pressure is required, the valve leading to the water tower is closed and the pump then delivers the water to the mains at 110 lbs. pressure.

In ordinary pumping the steam from the h.p. cylinders goes into the low pressure cylinders, but when required for higher pressures steam is admitted direct to the l. p. cylinders through a by-pass.

The deep well pump has a cylinder 12 in. in diameter, water cylinder 8 in. diameter, and 18 in. stroke. This pump is of Blake & Knowles make and has never been repaired or adjusted in any way since it was installed. For the last 12 months it has only stopped for a few hours each fortnight while the feed water heater was cleaned.

The well when first operated gave considerably

* Superintendent Electric Power and Waterworks.

more water than it does now, as the following comparison will show:—

Since 1911, water delivered per hour, 1,333 gallons.

Since 1915, water delivered per hour, 640 gallons.

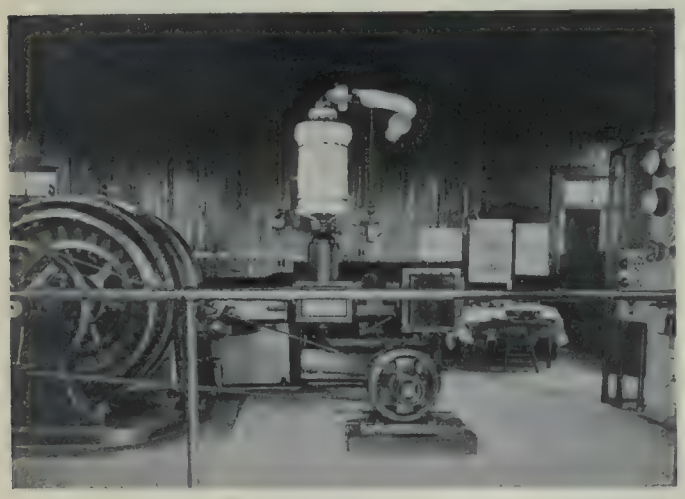
Also it will be noticed that the water consumption has increased very considerably:—

1911.		1915.	
Sept. ...	175,917 gallons	Sept. ...	296,787 gallons
Oct.	93,269 gallons	Oct.	321,831 gallons
Nov. ...	197,193 gallons	Nov. ...	389,931 gallons
Dec. ...	137,708 gallons	Dec.	381,100 gallons

This will be even greater this year, as up to last fall the mains were only in the main streets, and except for a few business places, were kept for fire purposes only. About September, last year, the mains were extended into the residential parts of the town and the water laid into the houses; therefore, this year will see a large increase even on last year's consumption. Realizing this, the town is about to put down another well, tenders having been invited for the work.

The electric light plant was added shortly after the pumping plant was installed and a new boiler of similar size and type, but of Waterous make, was added.

The generator is a 3-phase, 2,200 volts, 60 cycle,



Interior Electric Power Plant, Stettler, Alta.

125 kv.a., direct driven, made by the Swedish General Electric Co., excited by a small 110 volt, 45 amp. machine, belt driven off the main shaft. The engine is a Robb tandem compound, horizontal, running at 260 r.p.m., and of 200 h.p.

So far the loads have not been heavy enough to warrant the l.p. cylinder, and the engine has always run as a simple h.p. engine. Two generators of 100 h.p. would have been much more economical and provided against breakdown, and by having vertical engines could have ben put into the same space. Last winter's heaviest loads just reached over the 100 h.p. limit, so that next winter it may be necessary to couple in the l. p. end.

Except for a breakdown at the very first, this plant has run uninterruptedly for 4 years. Previous to last Oct. 15th, the service was only supplied from dusk to daylight, thereby depriving those people who could use an electric day service of its advantages. On the above date, however, the day service was commenced and the motor load in 6 months' time was over one-third of the lighting load.

Besides this, electric stoves and irons are coming more and more into use, and the various stores where oil lamps had to be used during the day in basements, are now using electricity to their own and the town's advantage.

The way this day service is run with only one generator is to shut down on Sunday from daylight to dusk for cleaning and repairs, and from 12 to 12.30 at noon each day for examination and oiling.

There is no condenser connected with the engine, all the steam blows into the air except what is used in heating the feed water. As there is a steam laundry near, arrangements may be made later on for them to buy the exhaust steam.

The feed water heater is of 200 h.p. capacity, made by Blake & Knowles, and of the open type. Water then flows by gravity to the two boiler feed pumps. Beside the feed pumps, 2 injectors are installed to take water from the town's mains if necessary, and water can be taken direct from the reservoir should the town's supply be cut off.

The town tank is 22 ft. high by 19 ft. diameter, and holds 50,000 gals., so that when both tank and reservoir are full, there is a reserve of 100,000 gallons of water. The tank is mounted on 4 girders and has a balcony around the bottom. This balcony is 100 ft. from the ground.

The water for boiler purposes seems remarkably good, leaving them in good shape with very little mud and no scale, and as yet no signs of pitting. A recent analysis has been made of this water and a copy is appended, as well as that of an analysis taken soon after the well was bored.

1911 Analysis—(Expressed in parts per million)

Total dissolved solids	1,257
Hardness	80
Alkalinity	124
Free Ammonia	392
Albuminoid Ammonia	156
Chlorine, as Chlorides	11

1915 Analysis—(Expressed in parts per million)

Total Solids	1,060
Loss on Ignition	85
Alkalinity	600
Hardness	197.3
Sulphates	192
Chlorine	6
Nitrates	Absent
Free Ammonia	.042
Albuminoid Ammonia	.026

The feed-water heater gets made up after a fortnight's run, with a kind of sandy deposit which has to be scraped off the plates, etc., and until the idea of blackleading the plates was tried, this deposit would fasten on them like cement and give a lot of trouble.

The coal costs, laid down at the plant, $2.85 per ton of 2,000 lbs., made up as follows: price at mine, $1.50; C.N.R. freight for 70 miles, $1.00; hauling from track to power house, 35c. The town has its own team and does the hauling. The track that would join the C. P. and C. N. Rys. has never yet been laid, so there is no spur whereby cars can be switched and unloaded direct at the plant.

The buildings are of wood throughout, faced with metal shingles and so designed that considerable expense will be incurred should extensions ever be necessary. The roof is flat and extremely low, so low, in fact, that the man have to bend almost double when working on the boilers, and up to last year no ventilation was provided in the roof. The firing floor is too narrow for easy working at the fires and the impression given is that of boxing the plant in as if land was so high priced that a $10 bill would only buy as much as it covered when standing on edge.

Freight Rates to Pacific Coast

The Transportation Department of the Canadian Manufacturers' Association are distributing the following information on Circular No. 110, dated June 24, 1916:—

IMPORTANT

Hand this Circular to the Man in Charge of Transportation Matters for Immediate Attention

The railways gave notice at a meeting held here this week that it was their intention to make the following additional changes in rates to the Pacific Coast.

If you have any objections, please send them in at once, with reasons in support thereof, as we are to have another meeting on July 6th, at Montreal.

Commodity	Rates in Cents per 100 lbs. Present	Proposed
Bags and Bagging, L.C.L	178	Cancel
Biscuits and Confectionery, C.L.	173	178
Bowling Alley Material, C.L.	138	145
Carpets and Rugs, L.C.L.	280	Cancel
China and Majolica Ware, L.C.L.	170	200
Cider and Vinegar (minimum weight advanced from 30,000 to 40,000 pounds.)		
Drugs and Medicines, L.C.L.	220	Cancel
Batts and Caulking Cotton, L.C.L.	195	220
Comfortables and Comforters, L.C.L.	195	220
Buttons, Agate and Pants, L.C.L.	195	220
Towels and Towelling, L.C.L. (other than cotton)	210	220
Earthenware and Chinaware, L.C.L.	168	170
C.L.	108	128
Fish, L.C.L.	195	Cancel
Rail or Track Door, L.C.L.	140	165
Peavies and Logging Tools, L.C.L.	190	Cancel
C.L.	130	135
Hollow-ware, Stove Furniture, L.C.L.	185	Cancel
Hose, Metallic, & Metallic Tubing, L.C.L.	178	220
Ink, Mucilage, Paste and Glue, L.C.L.	178	Cancel
Iron or Steel Bar, Rod, Hoop or Band, L.C.L.	143	Cancel
Bolts, Lag Bolts or Screws, Butts, Nut Locks, Rivets or Screws, L.C.L.	145	Cancel
Butts and Hinges, Hasps, Hooks, etc., L.C.L.	145	Cancel
Castings (finished), Agricultural Implement, School Desk, Waggon, Carriage, Sink Bracket, etc., L.C.L.	175	Cancel
Castings, N.O.S., Sprocket Wheels, etc., L.C.L,	175	Cancel
Chain, N.O.S., including Link Belting, L.C.L.	143	Cancel
Nails, Horseshoe, L.C.L.	163	Cancel
Iron or Steel, Plate and Steel, No. 11 and heavier, L.C.L.	145	Cancel
Iron or Steel Sheet, No. 12 and lighter, L.C.L.	145	Cancel
Horseshoes, L.C.L.	143	Cancel
Fruit Juice, L.C.L.	195	Cancel
Brandy, Gins, High Wines, etc., L.C.L.	195	Cancel
Lawn Mowers, L.C.L,	193	Cancel
Paints and Varnish, L.C.L.	145	Cancel
Paper Coin Wrappers, L.C.L.	193	215
Envelopes and Stationery, L.C.L.	215	Cancel
Fly or Insect Paper, L.C.L.	195	220
Paper Folders, for filing, L.C.L.	193	215
Paper Labels, L.C.L.	193	218
Book Paper, News, Poster, Cover, etc., L.C.L.	165	Cancel
Wrapping Paper, L.C.L.	165	Cancel
Writing Paper, flat, L.C.L.	165	Cancel
Writing Paper, plain, L.C.L.	215	Cancel
Sad Irons, not electric, L.C.L.	145	Cancel
Saws, N.O.S., and Hand Saws, L.C.L.	193	218
Sledges, Wedges and Mauls, L.C.L.	165	Cancel
Soap, Soap Chips, Washing, Scouring and Polishing Compounds, L.C.L.	145	Cancel
Seeds, L.C.L.	210	220
C.L.	134	148
Shoe Buttons, Hooks, Eyelets, and Horns, L.C.L.	210	220
Shoe Button Fastenings (wire staples), L.C.L.	193	220
Spices, Nutmegs, Mustard, Pepper, etc., L.C.L.	190	220
Tacks (for shoe machines), L.C.L.	190	218
Tacks, Iron, L.C.L.	193	Cancel
Wire Fencing, L.C.L.	190	Cancel
Twine and Cordage, L.C.L.	175	Cancel
Wire, Insulated or Covered, L.C.L.	200	Cancel
Wire, Iron, Plain or Galvanized, Tinned or Coppered, L.C.L.	178	Cancel
Wire, Telephone or Electric Light Cables, L.C.L.	200	Cancel
Oil Cloth, Linoleum, Cork Carpet, etc., L.C.L.	135	Cancel

The present rate shown above will be found in C.P.R. Tariff No. E. 2632, C.N.R., No. E. 706, and G.T.R., No. C.N. 154.

Yours faithfully,
J. E. Walsh,
Manager, Transportation Dept.

L.C.L.—Less than car loads.
C.L.—Car loads.
N.O.S.—Not otherwise specified.
Cancel.—Commodity rate cancelled. Class rates to apply in future.

Milk Products Factory at Burford

The Canadian Milk Products, Limited, Mail Building, Toronto, announce that a property has been secured in the village of Burford, Ont., for the erection of a milk product plant. This plant, it is claimed, will be unique in building construction for several reasons. For example, the walls of the building will be built of 8-in x 10-in x 16-in. vitrified salt glazed rock face tile. The building will be one storey construction, with a floor area of approximately 160 ft. x 10 ft. The roof will be of wood and finished with tar and gravel.

The machinery and equipment of this plant will be the most up-to-date obtainable, built especially for the production of powdered milk. This company already have two fine plants in Canada, at Brownsville, Ont., and Belmont, Ont., but these will be excelled by the Burford plant. All machinery and apparatus handling the liquid milk will be porcelain lined, for sanitary reasons. All apparatus which will handle the powdered milk after it has passed beyond the liquid state will be constructed in the most sanitary way for handling and production of such an important and staple food product.

Milk powder is coming into a common use in construction and engineering camps, where condensed and evaporated milk only have been used in the past. Having milk in an absolutely dry and pure state offers advantages that any employer of large numbers of men can readily realize. No foreign or chemical ingredients of any kind are used in the production of powdered milk. It is nothing but all of the pure solids of the fresh liquid milk obtained by evaporating the

87½ per cent. of water from the fresh liquid milk as it comes from the cows. The whole process is carried on without subjecting the milk to a temperature higher than the standard temperature of pasteurization. This company state that the only milk used by all of the soldiers in every camp in Canada since the beginning of the war has been powered milk made by Canadian Milk Products, Limited.

How the Contractor Can Advertise and Get Results

"How can a general contractor advertise?"

Which, of course, means how can he obtain the right kind of publicity; the kind that will do more than fill advertising space and cost money—in a word, the kind that pulls?

The principles of advertising are the same whether you are endeavoring to sell books, bricks, or office buildings, or seeking to get your name on the architect's lists. The only things that change are the manner and methods of publicity. A general contractor must therefore adopt methods suitable to his own particular business, which, by the way, is decidedly different from any other type of business, and must have its advertising done and copy written by men who understand, in a most comprehensive manner, the details and intricacies of the building trade.

Then, again, the advertising must be of a twofold nature, inasmuch as its appeal must reach both architects and owners—two different types of men, and in most cases with very little in common so far as their training is concerned.

To the architect, the builder's advertisement must appeal with such riveting force as to be ever before him. If not in a physical manner, at least mentally it must make a little dent in his mind and "ring the bell" at the psychological moment when the architect is making up his list of bidders, and the nearer the top of the list the better his chance of always being among the favored few.

You may say that you already do enough estimating and are now working overtime trying to land jobs. Are you on the lists of all of the prominent architects, the men for whom you would like to estimate? Are you in a position to select the good prospects and avoid the poor ones? In a word, are you competing against men who do the same cadibre of work that you are doing, or are you forced out of your class because you are not on the chosen lists? If you cannot answer these questions to your entire satisfaction, then you are ready for serious thought on the question of advertising.

Revising Quebec Health Laws

Sir John Kennedy and Messrs. W. S. Lea, J. O. Meadows, and A. Surveyer, represented the Canadian Society of Civil Engineers as a deputation to the Superior Board of Health of the Province of Quebec, requesting amendments to the Provincial Health Act. It was suggested that at least two engineers should hold membership on the Superior Board in view of the importance of engineering in sanitary undertakings; that plans submitted to the Superior Board should always be prepared by competent engineers; that rules be enacted governing the filing of plans; that extensions to plans should be submitted to the Board the same as new projects; and that no municipality be allowed to submit projects for waterworks to the electors without first having secured the approval of the Superior Board. Consideration was promised to the suggestions.

New Sherbrooke Bell Exchange

The Bell Telephone Co. of Canada, have recently completed the erection of a new office and exchange building on Strathcona Square, at the corner of Terrace Street. in the city of Sherbrooke. The building has a frontage of 40 feet on Strathcona Square, and a depth of approximately 75 feet on Terrace Street. It is 3 storeys and basement high, and provision is made for a future additional storey and also for the ultimate extension of the building to the extreme end of the lot.

It is designed and built according to the most modern practice applied to this type of telephone buildings; and in relation to fire resisting constructional methods. The structural floors, beams, columns, exterior wall, interior main partitions, are of reinforced concrete, brick, stone, cement, terra cotta, etc. Wood is practically eliminated throughout the construction. The Terrace Street front and the east side, looking towards Wellington Street, are built of Queenston limestone, carried on a Stanstead gray granite base beneath.

The treatment is simple and dignified and was designedly made to harmonize with the adjacent buildings facing on Strathcona Square. The main entrance in the centre of

the front, looking over the square, is approached from either side by a stone terrace finished with a granite parapet, on the balustrade of which are two handsome electric lamp posts, which efficiently illuminate the front of the building.

From the main entrance vestibule to the operating room on the third floor there is a continuous corridor and staircase hall, separated from the adjacent offices and other apartments in the most fire-resisting manner possible. The doors from it entering into these other premises being Underwriters' hollow steel, 3 point lock pattern. The windows throughout are Underwriters' pattern, made of hollow metal and glazed with heavy wired glass. On the right hand of the ground floor corridor, at the top of the vestibule steps, is a commodious public office and pay station, giving direct access to the Division Superintendent, business office, and telephone booths.

Special provision is made in the entrance vestibule, so that it can be used by the public to telephone after offices are closed for the day. Behind the public and business offices are those of the Local Plant Department, and lavatories for men and women, finished with impervious floors, marble trim, and high-grade type of basins and sanitary fittings; and on the left hand side of the main corridor, directly opposite the Bell Telephone Co.'s public office, are the offices of the

Eastern Townships Telephone Co. The terminal and battery rooms are arranged across the front of the first storey, while the operators' cloak, lunch, retiring and toilet rooms occupy the balance of this floor at the rear.

The whole of the second floor will be used for the operating room. At the rear from the operating room to the yard level is an iron fire escape communicating with each floor, and so arranged that it is almost impossible for it to be obstructed by smoke from the adjacent doors or windows. It is really a complete exterior staircase, as efficient and easy to go up and down as the main interior staircase; differing entirely in this respect from the fire escapes very generally seen.

In the basement are linemen's and inspectors' quarters, furnaces and coal rooms, fireproof stock and general storerooms. At the rear of the property is a 2-storey brick stores shed, 30 feet long by about 16 feet wide, for the storage of cable reeds, wire, and other heavy supplies.

When the telephone service grows to such an extent that the present operating room will not accommodate sufficient switchboards, it will mean necessarily that it and the first floor beneath will be extended backwards to provide additional operating room, terminal room, operators' accommodations, and the consequent extension of the space required on the ground floor for commercial or plant offices. This can be done at any time, or from time to time as required, to the limit of the rear end of the lot, without at any time disturbing the existing service or business conditions which may have accommodations in the building at the time that any such extension may be required. The building was designed by Mr. W. J. Carmichael, and constructed by Anglins, Limited, Montreal.

In the Public Eye

A budget of comment presented in the interest of public welfare, independent of party politics and with malice toward no one.

"Defective" Ammunition Traffic

In the House of Commons, May 13, 1916, Mr. D. D. McKenzie, M.P., charged Sir Sam Hughes with the following transaction:—

"That it appears from official papers laid on the table of this House, that the Minister of Militia, since the beginning of the war, illegally and without any power or authority, sold a quantity of small ammunition exceeding 3,000,000 rounds, to J. Wesley Allison, who represented himself as acting for Vickers, Maxim, Ltd., at a price of $20 per thousand rounds. That the quantity first intended to be sold was 5,000,000 rounds, and that over 3,000,000 rounds was actually delivered."

According to the Hansard report, Sir Robert Borden, on the same day, defending the transaction, stated that:—

"The only ammunition sold is Mark VI., two million rounds of which had been condemned as absolutely unserviceable."

It has since developed in the evidence given before the commission of inquiry presided over by Sir Charles Davidson, that this "absolutely unserviceable" ammunition was sold, through the agency of Mr. J. Wesley Allison, to the British Admiralty.

When the Auditor-General in the first instance drew the attention of Sir Thomas White to the transaction, by asking for an Order-in-Council after vainly asking for one from the Department of Militia, he made the following statement in the letter to the Minister of Finance:—

"I have reason to believe that the ammunition was resold at an advance of about 25 per cent., and that its destination was not Vickers, Limited. I may be mistaken in this, but Colonel Allison's connection with the transaction does not tend to allay suspicion."

Sir Sam Hughes, following the lead of Sir Robert Borden in defending the transaction, according to the Hansard report, denounced and threatened the Auditor-General in the following terms:—

"But when the Auditor-General undertakes to say what he has said in the document which has been read; when he makes reflection upon a gentleman who has more honor in his little finger than the Auditor-General has in his whole carcass, I want to tell him that I will find some means of reaching the Auditor-General."

In the same Hansard report the Dominion Minister of Militia said:—

"The statement was made that it was not known where the ammunition was going. The correspondence brought down clearly shows that it was ordered by the firm of Vickers-Maxim, one of the most reputable firms in the world, and was shipped to them, and that the money was paid by them to the Bank of Montreal in England. The statement was made that the ammunition was resold. That statement is absolutely untrue. The ammunition was sold to Vickers-Maxim and the address given of one of their officers."

Before the Davidson Commission on May 25, a few days after Sir Sam Hughes' assertion in the House of Commons, Mr. F. Orr Lewis, president of Canadian Vickers, Limited, gave the following evidence:—

"May I state that Canadian Vickers had no interest in the matter, and the English firm of Vickers had no interest in it."

Furthermore, with regard to the charge that the ammunition had been resold at an increase of 25 per cent., Sir Sam Hughes stated in the House of Commons (Hansard report, May 13, 1916):—

"There was no commission paid, offered, or asked for, by anyone in the transaction. That was brought out this morning before the Davidson Commission. We got $20, and that was all that was paid for the ammunition, so that there could not be any commission."

Before the Davidson Commission it has since been brought out that the ammunition was actually sold to the British Admiralty; and on June 13, last Tuesday, Auditor-General Fraser produced a cable from the Colonial Secretary stating that the price paid by the Admiralty for the ammunition was $25 per thousand, f.o.b. Canada, plus freight and insurance. The communication was sent and the reply received through H.R.H. the Governor-General.

Thus the evidence of June 13; and the following is from Sir Sam Hughes' statement as printed in Hansard of May 13:—

"This ammunition was first ordered, I say, by the members of the Vickers firm. Finally it was ordered by Col. J. Wesley Allison, who has the honor of being the Vickers representative, and who had, and still has, the honor of having been selected by the special representative of the British Government as agent in the United States of America in respect of very large matters of international concern. He is a gentleman who to-day stands high in the estimation of the people of the country, not from fear—"

Protests at this point interrupted the Dominion Minister in the House of Commons. A heavy national and Imperial responsibility is plainly developing upon Sir Charles Davidson, as Commissioner inquiring into the sale of Canadian Government ammunition, "absolutely unserviceable" and "defective," to the British Admiralty.—Ottawa Citizen (Independent Conservative).

Mainly Constructional

East and West—From Coast to Coast

Work on the civic street car barns on Bracondale Avenue, Toronto, for which the permit was recently issued, has just been commenced.

A permit for $6,000 has been issued to the Victor Saw Works, of Hamilton, for the erection of a factory on Adam Street, to be built of brick. H. C. Gumo is the contractor.

Pig iron production in May broke all records, the output of 3,351,073 tons being 13,382 above the previous monthly maximum and the daily average of 108,099 running 433 tons ahead of the earlier record.

It is understood that a new company has been formed to buy the property of the Standard Ideal Company, at Port Hope, Ont. This company is engaged in the manufacture of sanitary enamelled goods, bathroom fixings, etc.

The John E. Russell Contracting Co. and the Weddell Company, of Trenton, who were awarded the contracts for the new crib and concrete headwall in connection with the Toronto harbor improvements, have started operations.

It has been recommended by the Hamilton Board of Control that Mr. E. R. Gray, assistant city engineer, be advanced to the chief engineership, and that Mr. A. P. Kappele, the present secretary of the works department, be made business manager.

Building operations in the city of Quebec continue to be very extensive. There were 43 permits issued in one week recently, representing the sum of $115,475. Amongst these was included a permit for a new wing on the Young Men's Christian Association building, St. Anne Street, for $57,000.

The Bricklayers' International Union recently elected the following officers:—President, William Jenoves; vice-president, John Spencer; permanent secretary, Joseph Pember; treasurer, W. Thorn; recording secretary, E. Keenworth; trustees, J. Addams, W. Damp, O. W. Wills; guards, John McCulloch, B. Loeman.

The Calgary Herald reports that E. R. Leverson, of that city, a building contractor, who was connected with the construction of the elevators of the Alberta Farmers' Co-operative Company, in 1913 and 1914, has been arrested on charges of fraud, conspiracy and contravention of the Secret Commissions Act, which total many thousand dollars.

At the annual meeting of the Regina Builders' Exchange held recently, the following officers were elected for the coming year:—President, W. M. Wilson; vice-president, D. D. Smith; secretary, M. L. Moyer; treasurer, A. Young; executive committee, W. R. Harris, R. J. Lecky, D. J. MacKay W. R. Talbot, W. Whiteford, J. M. Adam, W. J, Hastings, J. M. Taylor, and T. A. Wilson.

The Montreal Committee on Public Monuments has suggested to the City Council that an aesthetic committee be organized for Montreal and that no building permit should be granted until the plans are accepted by the committee. The latter is to have the power of deciding on the building line, the height and material of the building, as well as the designs of the facades on the principal city streets.

The annual meeting of the shareholders of Saskatchewan Coal, Brick & Power, Ltd., was recently held at Estevan, Sask., and it was decided to make a call for an additional 25 per cent. of the prescribed capital, for the purpose of meeting the payment on the purchase price of the property and continuing development of the business. President Kennedy, vice-president J. E. Loughlin, and secretary-treasurer J. G. Moffatt were re-elected, along with a board of directors composed of prominent business men and farmers of the province.

At a recent meeting of the Nova Scotia Steel & Coal Company's directors, the regular preferred dividend for the quarter ending June 30th, was declared, and it was reported that shipments during the month of May had created a new monthly record, and that several new daily records also were made during the month. The work of building the steamer at New Glasgow in which the company is interested, has begun, the bending of the frames having started a short time ago. The steamer will be 2,000 tons register.

Hon. Finlay Macdiarmid, Minister of Public Works, announces that the result of the inspection tour of the proposed new highway between Ottawa and Prescott, from which Deputy Minister McLeod has just returned, a government survey for the highway will be undertaken almost immediately. The survey, it is expected, will occupy about a month, and a survey party of ten men will be engaged. The appointment of a commission will not be made until after the survey has been completed. It is expected that the work will cost somewhere in the neighborhood of $600,000.

A new industry will be started in Winnipeg, Man., very shortly by the Western Canada Marble & Tile Co., Ltd. The old site of the Lewis Carriage Co.'s works, on West Portage Avenue, which has a frontage of 110 feet and a depth of 659 feet, has been purchased by the new concern. The old building will be used, and a new finishing plant, 172 ft. x 52 ft., has been practically completed. W. B. Purtell is the president of the company, the vice-president is Harold Smith, and the secretary and treasurer, J. C. Purtell. The plant will cost $10,000 and the machinery installed about $20,000 more.

About 1,100 workmen and 100 teams are at present employed, working night and day, on the main block of the Parliament Buildings at Ottawa, reducing such parts of the structure as the fire did not destroy, and reconstructing the building. In spite of the large scale of operations it will be at least two years, and more, probably three, before the work has been completed. Peter Lyall & Sons have undertaken the rebuilding of the main block on a commission basis, 10 per cent. of the total cost, it is understood, at present estimated to be about $4,000,000. The western wing is to be torn down, and it is in this section that the new House of Commons and the Senate are to be located. Peter Lyall & Sons will equip a stone-cutting plant for the cutting of the sandstone blocks necessary for the reconstruction.

Obituary

The death is announced of Mr. E. L. Rowan-Legg, C.E., of the Department of the Interior, Ottawa, at the age of 69 years. He came to Canada from Ireland, his birthplace, in 1869, and was one of the engineers engaged on the location survey on the Dawson route of the C.P.R., and also in the construction of C.P.R.'s North Shore Line. In 1883 he entered the Topographical Survey of the Dept. of the Interior and has been actively engaged there since.

Alderman R. M. Roy, C.E., chairman of the works committee of the city of Hamilton, Ont., passed away recently, following an illness which confined him to the house for about a month. The deceased alderman was a native of Belleville, where he received his education and entered the employ of J. & G. Brown, building contractors. A short time later his exceptional ability won him a position with the engineering department of the Grand Trunk Railway and afterwards with the engineers' staff of the Central Bridge Works, of Peterboro. About twenty years ago Mr. Roy went to Hamilton to assume charge of the highway bridge work of the Hamilton Bridge Works Company, Limited, and five years ago he became manager of the company. For three years he had served as alderman, during two of which he had been chairman of the works committee.

Chlorination Requires Careful Supervision

By Joseph Race*

WHEN chlorination was first introduced for the sterilization of water and sewage, all that was required was the addition of the hypochlorite; the process was then supposed to take care of itself. Tests show that greatest efficiency depends upon attention to details.

Hypochlorite solution was added in the sedimentation basin at the entrance of the Ottawa, Canada, water intake July, 1914, by means of a perforated pipe. The mixture was effected as thoroughly as possible without recourse to mechanical methods. During August the bleach liquor was added directly to the suctions of the low-lift pumps, which take water from the sedimentation basin and place it in the intake pipe under a small positive pressure until it reaches the high-lift pumps. Tests showed that the latter method of mixing gives much superior results with a smaller consumption of chlorine.

Effect of Color

Experiments showed that color reduces the efficiency of chlorination and necessitates a much larger dose. About 2½ times as much chlorine has been found to be necessary in treating water of color forty for one hour at 63 deg. Fahr. to get the results obtained with water practically free from color. Water at the Montreal intake, free from color, required about 0.3 part per million of available chlorine for satisfactory treatment.

Tests to determine the effect of temperature showed that 10 cc. of water of color forty containing 0.4 part per million of available chlorine retained only two of the original 424 colonies after being subjected to a temperature of 36 deg. Fahr. for twenty-four hours. All colonies were destroyed after twenty-four hours at 70 deg. Fahr. and only three of the original 424 colonies remained when a temperature of 98 deg. Fahr. was manitained for four and one-half hours.

It has been stated that after the preliminary germicidal action has subsided a second phase occurs in which there is an accelerated growth of organism known as aftergrowth. The aftergrowths obtained under usual working conditions vary according to the dosage of chlorine. When it is small few active organisms, in addition to spore bearers, will escape destruction. Others will suffer a reduction of reproductive capacity.

There is a persistent decrease in the number of B. coli organisms as the contact period is increased. The time required for the completion of two cycles comprising the first reduction caused by the chlorine, the increase or aftergrowth and the final reduction due to lack of suitable food material, depends upon various factors of which the dosage and temperature are the most important. With a small dosage the germicidal period is short and the second phase quickly reached; with large doses the second phase is not reached within forty-eight hours.

Low temperatures reduce the velocity of the germicidal action but extend the period over which it is effective. The higher the temperature the quicker are the action and development of the aftergrowth. These statements refer only to the total bacteria as found by development on nutrient agar. The B. coli did not act in this way and persistently diminished in every case.

Tests were made to determine the free carbonic acid in the raw and treated waters at Ottawa. During a period of excessive turbidity and pollution a heavy dose of chlorine was used and an increase in the free carbonic acid resulted. It was found that there was no increased corrosive action due to that acid. With the usual dosages of chlorine the increased electric conductivity had no practical significance at ordinary temperatures. At temperatures approaching the boiling point of water the percentage increase of conductivity is somewhat greater and possibly of practical importance.

Experiments were made to ascertain whether the B. coli found after chlorination were more resistant to chlorine than the original culture. The colonies surviving after treatment with comparatively large doses were fished into lactose broth and this culture used for a second chlorination. The surviving organisms were again fished and the process repeated several times. No evidence was obtained that the surviving organisms were in any way more resistant to chlorine than the original culture. A number of the colonies surviving several chlorinations were cultivated in lactose broth. All of the cultures produced less acid than the original one and the average was considerably less than the original cultivated under the same conditions, showing that the bio-chemical activity was diminsihed.

* City Bacteriologist and Chemist, Ottawa, in Engineering Record.

New Machine Shop in Galt

The Roelofson Machine & Tool Co., Ltd., have decided to build a modern factory building in the Jackson Park manufacturing district in Galt, Ont., and work on the plant is already under way. Mr. E. C. Roelofson is president and general manager of the company, and his brother, Mr. A. C. Roelofson, will be works manager. The company, which is at present located in Toronto, are the Canadian representatives for the Potter and Johnston Machine Co., of Pawtucket, Rhode Island, and will use part of the new works as a warehouse for the lines of the American firm. The head office and sales office of the company will still be maintained at 1501 Royal Bank Building, Toronto. The new building, of which J. E. Evans is the architect, will be located on a three-acre site. It will have a concrete foundation, with concrete floors throughout, and will be single storey of red brick superstructure, with artificial stone trimmings, made locally. It will be of an L-shape, with a frontage of 185 feet on Beverly Street and a depth of 105 feet, exclusive of office and boiler room. The boiler room will be 28 x 30 feet in dimensions, also one storey, and excavated to a depth of eight feet below the main floor to provide gravity return for the heating system. This building will be separate from the main plant. The office, which will be located on the southeast corner of the plant, will be two storeys, 30 ft. x 42 ft. On the lower floor will be a vestibule, general office, two private offices, vault and lavatories, and on the second floor there will be located the drafting room, superintendent's office, vault, and the necessary lavatory accommodation. In the factory building all the windows will be of steel sash and the factory when completed will be one of the most modern in Ontario. The framing and roofing will be of mill construction, with the latest method of saw-tooth lighting, all the light coming from the north. Provision has been made for future extensions to the east. Thomas and Hancock are the contractors for the new plant.

Railways in British Columbia are experiencing a shortage of labor for construction work.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Chatham, Ont.
The City Council contemplate the construction of about 3,700 square yards of reinforced concrete pavement. Chairman of Board of Works, W. A. Hammond.

Hull, Que.
The City Council are considering the construction of sewers at an approximate cost of $20,000, and watermains estimated to cost $35,000. Engineer, J. P. A. Laforest.

Malden Township, Ont.
A by-law will be submitted to the ratepayers on August 7th to authorize the raising of $10,000 for construction of tile drains. Clerk, E. H. Bratt, Malden.

Merritton, Ont.
The Town Council are about to construct sidewalks and concrete pavements by day labor. Approximate cost, $6,000. Engineer, F. Rutherford, 24 Queen St., St. Catharines.

Orford Township, Ont.
The Township Clerk, F. Littlejohns, Highgate, Ont., will receive tenders until July 15th for the construction of a quantity of tile drains, varying between 6 and 14-inch.

Ottawa, Ont.
Work is about to start on the survey of the proposed highway between Ottawa and Prescott, a distance of about 60 miles. Estimated cost, $600,000. Deputy Minister of Highways, W. A. McLean, Toronto.

The City Council propose to lay about 1,410 square yards of asphalt pavement with gutter, estimated to cost $5,219. Engineer, F. C. Askwith.

Sault Ste. Marie, Ont.
The City Council are considering the construction of a waterworks system to take a supply from Coldwater Creek, the estimated cost of the scheme being $300,000. Clerk, R. G. Campbell.

Westmount, Que.
The City Council propose to spend $22,500 on the construction of asphalt pavements on concrete base. Engineer, P. E. Jarman.

CONTRACTS AWARDED

Edmonton, Alta.
The City Council have let the contract for construction of plank sidewalks in Edmonton South to Hulbert Wilson & Southworth, 10363 Whyte Avenue, and the contract for Edmonton North to Whitney & Morgan. Approximate total cost, $25,000.

Guelph, Ont.
The contract for supply of storm sewer pipe has been let by the City Council to B. Blair & Company, Woodstock. Approximate amount, $3,000.

North Bay, Ont.
The Town Council rave let a contract for watermain extensions to A. Chirico, care of the Clerk, W. K. P. Kennedy.

Railroads, Bridges and Wharves

Grey County, Ont.
Tenders are now being received for the construction of a bridge between the Townships of Emphrasia and Artemisia. Plans and specifications with the Clerks of both Townships and with the Engineer, R. McDougal, 635 Second Avenue, Owen Sound.

Sombra & Chatham Townships, Ont.
The Townships Council are considering the construction of ten concrete and steel bridges.

Toronto, Ont.
The Toronto Harbor Commissioners have filed plans for the bastion sea wall to be built at the mouth of the Humber River. Engineer, E. L. Cousins, 50 Bay Street.

CONTRACTS AWARDED

Mountain, Ont.
The Council have awarded the contract for construction of a concrete bridge to R. J. Dougall, Hallville, Ont. Approximate cost, $2,500.

Public Buildings, Churches and Schools

Galt, Ont.
The Separate School Board propose to build a two-storey school addition, and plans are being prepared by John Evans, 30 Water Street North.

Montreal, Que.
In connection with the erection of the proposed building on St. Lawrence St. for the Deaf and Dumb Institute, 1941 St. Dominique Street, only the basement will be built this year, the remainder of work being held over till next year. Tenders are wanted for roofing, plumbing, electrical work and plastering.

The Department of Public Works, Ottawa, will receive tenders until 4 p.m., July 10th, for alterations and additions to the heating system at the Ceneral Post Office. Plans and specifications at office of R. L. Deschamps, Central Post Office, and at the Department. Specifications only at office of MacLean Daily Reports, Ltd., 25 Charlotte Street, Toronto.

New Liskeard, Ont.
The Provincial Department of Public Works propose to build an Agricultural High School at an approximate cost of $90,000. Plans are being prepared by F. R. Heakes, Parliament Buildings, Toronto. Brick, stone and steel construction.

Quebec, Que.
In connection with the Church which is being built for the Parish of St. Roch, plans for the interior work are now being prepared by the Architects, Talbot & Dionne, 16 St. Joseph Street.

St. Elie D'Orford, Que.
Plans of a Church and Presbytery are being prepared by F. Audet, 361 Dorchester Street, Sherbrooke, and tenders will be called. Stone construction.

Yorkton, Sask.
Plans are to be prepared for a Boarding School to be built for the Redemptorist Order at an approximate cost of $40,000. Half of this amount will be spent this year.

CONTRACTS AWARDED

Addison, Ont.
The contract for the erection of a Church for the Anglican Church, Lyn, Ont., has been awarded to A. Haggerty, Brockville. Stone construction. Approximate cost, $4,000.

Brockville, Ont.
The contract for masonry required in the erection of a Home for Old Women has been let to A. Cameron, Alexandria, Ont.

Calgary, Alta.
The contract for plumbing required in the erection of a school on Centre Avenue for the Separate School Board has been awarded to R. W. Snyder, East Calgary.

Chicoutimi, Que.
The contract for brick work required in the erection of a Monastery has been let to Ernest Bouchard, Begin Avenue. Other work by day labor under supervision of Hermias Lavoie. Approximate cost, $75,000. Stone and brick construction.

Elrose, Sask.
The general contract for the erection of a school for School District No. 3478 has been awarded to Miners & Ball, Saskatoon. Approximate cost, $6,330.

Jonquiere, Que.
The School Board have awarded the general contract for the erection of a Convent to William Lavoie & Frere, Jonquiere. Brick, steel and frame construction. Approximate cost, $15,000.

London, Ont.
The Board of Education have awarded the general contract for the erection of a Technical School to John Putherbough, 1006 Wellington Street, at $120,000; heating and plumbing to Egget & Company, 335 Ridout Street, at $29,500,

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A Substitute for Labor

ONE effect that war has imposed upon constructional work throughout Canada is a scarcity of labor. So difficult is it becoming to obtain suitable or sufficient men to carry on building work that there is an increasing danger of certain work being delayed or stopped altogether. Accompanying labor scarciey is, naturally, a rising labor cost, which in many cases is out of all proportion to the skill and ability at present obtainable. This condition of affairs is a very real obstacle to our building operations, but must be borne with patience as a necessary by-product of a state of war. Such a condition is very detrimental to the building activity of the country and if a corrective is not applied will have a tendency to hold back future projects until the labor market is relieved. This ought not to happen, because what Canada needs at the present time more than any other thing is that which will create and maintain a spirit of hopefulness and optimism. Nothing can, perhaps, do this more than active and normal building operations. Elsewhere in this issue is published a list, perhaps not absolutely comprehensive, but at least sufficient to show that Canada's condition is not at as low an ebb as there is a tendency to imagine. Many extensive projects are planned; on many of them work is to begin shortly, but a very real retarding feature is the scarcity of labor, which, together with its high cost, tends to make building operations expensive.

But whatever may be the evil of the situation, it at least cannot fail to stimulate thought along one line, which, from an engineering viewpoint, ought to be a most beneficial result. We have in mind the question of how mechanical equipment can be employed in place of hand labor.

The use of machinery in the form of labor-saving devices keeps down the ultimate cost of construction work by increasing the production per man employed, and it is unnecessary to mention its advantages in the matter of time saving. In an age when rapid development is a characteristic, the provision of labor-saving devices is of paramount importance. Short cuts are the order of the day, and hand labor is not a producer of by-ways. Contracting equipment of a specialized order is the requisite need. It is probable that from the present situation will be evolved wider uses of available machinery with the introduction of new equipment and new methods. The condition today is regrettable, but out of it should come valuable knowledge.

Not So Bad After All

AN analysis of the constructional work progressing throughout Canada exhibits a most optimistic and hopeful situation, all the more so when it is considered that the country is laboring under the depression naturally caused by war. Nothing could be of more real benefit to the people of this country than extensive building of the proper kind. The present prosperous situation is undoubtedly a reaction from the first effects of war when the natural inclination was to economize and save by discontinuing construction. Although economy is urged, it is believed that judicious building at a time like this not only creates a spirit of hopefulness, but it provides a field for labor and places money in circulation. Further, it provides a more stable foundation for the development which must inevitably follow the termination of the war.

With the thought of reminding our citizens that constructional work is not by any means at a low ebb, the Contract Record offers the following list of work initiated during the present year. Doubtless it is incomplete, but from such an array of figures the only conclusion that can be arrived at is that our building work, both in quantity and value, is extremely gratifying and would do justice to Canada even at a time not troubled by war. This ought to clear the minds of Canadians on this point and should show them that even under adverse conditions, the country is not afraid to continue its commercial industry and business development.

A most noteworthy fact is that a very large portion of the buildings in progress belong to a class valued at $100,000 or over, which shows that people and corporations in a position to spend large sums of money are not lacking. Of works in construction involving a million dollars and over there are not a few extensive and important projects. It will be noted that no work of a lesser value than $100,000 is in-

cluded in this list. Below that figure comes a very long list of schools, churches and municipal work of various sorts.

Prominent Construction Work of 1916

Dominion Parliament Buildings	$5,000,000
Toronto Union Station	3,500,000
Manitoba Parliament Buildings	3,000,000
Wm. Davies Abattoir, Toronto	1,500,000
Dominion Sugar Company Factory, Chatham	1,000,000
Vancouver Terminals, C. N. P. Ry.	1,000,000
Oil Refinery, Regina	1,000,000
Loew's Theatre, Montreal	1,000,000
Eaton Factory, Toronto	750,000
Simpson Factory, Toronto	750,000
Gold Mill, Timmins, Ont.	750,000
Armstrong-Whitworth Rolling Mills, Longueuil, Que.	750,000
Goodyear Factory, New Toronto	750,000
T. Eaton Company Warehouse, Winnipeg	600,000
Custom House, Toronto	500,000
St. Joseph's Novitiate	500,000
Latter Day Saints' Temple, Cardston, Alta.	500,000
Bank of Hamilton, Winnipeg	400,000
Malt Mills, St. Boniface, Man.	350,000
Commercial College, Quebec, Que.	300,000
Freight Sheds and Grain Elevators, Quebec, Que.	300,000
Aetna Chemical Co. Sulphuric Acid Plant, Drummondville, Que.	300,000
St. Roch Church, Quebec, Que.	300,000
Hydro-electric offices, Toronto	300,000
Coal Handling Plant, Fort William	300,000
Deaf and Dumb Institute, Montreal	280,000
Steel Bridge, St. Boniface, Man.	264,000
Theatre, Montreal	250,000
Elevator, Fort William	250,000
Robert Simpson Co. Employees' Home, Toronto.	250,000
St. Pierre Claver School, Montreal	250,000
Grain Exchange, Winnipeg	250,000
Trusts and Guarantee Building, Toronto	200,000
McLaughlin Residence, Oshawa	200,000
Oratoire St. Boniface Church Crypt, Montreal	200,000
Pulp Mills, St. Valician, Que. (to start)	200,000
Technical School, London, Ont.	200,000
Salt Factory, Sandwich, Ont.	200,000
Flour Mill, Medicine Hat, Alta.	200,000
Park School, Toronto	200,000
St. Jean Berchman Church and Presbytery, Montreal	200,000
Princess Theatre, Toronto	200,000
St. Michael's Cathedral, Sherbrooke, Que.	175,000
St. Vincent Girls' High School, St. John, N.B.	150,000
Gutta Percha Rubber Factory, Toronto	150,000
Collegiate, Windsor, Ont.	150,000
Ogilvie Flour Mill, Fort William	150,000
Russell Motor Car Factory, Weston, Ont.	150,000
Power Plant, Orillia, Ont.	140,000
Cote des Nieges School and Residence, Montreal.	140,000
Knitting Mills, Hamilton, Ont.	125,000
Pretoria Bridge, Ottawa	120,000
Carborundum Plant, Stamford Township, Ont.	100,000
Province Hospital, Moose Jaw, Sask.	100,000
F. F. Dalley Factory, Hamilton, Ont.	125,000
St. Pierre Claver Church, Montreal	100,000
T. Eaton Factory, Hamilton, Ont.	100,000
Court House, Sault Ste. Marie, Ont. (tenders open)	100,000
Chevrolet Motor Co., Oshawa	100,000

The above list, as already noted, includes only those buildings or projects upon which construction has begun this year or is practically certain to begin. In addition to these there are a great number of extensive works at present under way which were started previous to this year. Some of the more important of these are listed below, although this is not claimed to be complete nor does it include any railway construction work or roadways.

Welland Ship Canal	$50,000,000
Quebec Bridge	25,000,000
Greater Winnipeg Water District	15,000,000
Toronto Harbor Development	15,000,000
Halifax Terminals	10,000,000
Levis Dry Dock	3,000,000
Manitoba Parliament Buildings	3,000,000
Sun Life Offices, Montreal	1,500,000

Better Business Methods

Better business methods are the paramount need of the commercial world to-day. Industrial and other business institutions are realizing this more and more, and especially is there a marked tendency at the present time, when profits are more difficult to secure, to install more efficient organization based on revised methods. Poor methods are doubly conductive to poor results, and too many of our failures trace their origin to the unmethodical systems applied to the conduct of our businesses.

A proper study of costs, as one phase of more efficient business methods, is a step towards reasonable and certain profits. The lack of a proper cost account system often leads to failure. In this connection it would appear that the importance of better business methods in Canada has not been fully appreciated yet by the state. On the other side of the line there was instituted about a year ago a Federal Trade Commission, a permanent, non-partisan organization, composed of particularly capable and prominent men, well versed by extensive experience with the commercial and industrial situation in the United States. The purpose of this commission is to deal with business problems within a large scope; its powers are wide and its activities comprehensive. It is empowered to deal with trade disputes and unfair trade practices and to eliminate monopolistic control, and these duties it is claimed to have performed in a most friendly and agreeable manner. But outside of these punitive and compulsory powers, the important policy and aim of this group of men is the promotion of a healthy business co-operation; it is striving to help industry to compete more efficiently and intelligently in domestic and foreign trade. This aim is carried out by an intelligent study and investigation of industrial conditions and the methods used by U. S. business institutions. The policy is thus to promote industrial organization by a revision of business methods.

This commission has realized that cost keeping is the basis of more efficient success, and it is urging the subject of costs upon the business men of the country and offering to help in the formation of efficient cost-keeping systems, feeling that in this it is perhaps being of the greatest possible benefit. The statement of Hon. Edward N. Hurley, vice-chairman of the Federal Trade Commission, in a recent address before a group of business men, is particularly and singularly important in this regard. He says:—

"The Federal Trade Commission has been in existence one year, and upon surveying the field we found, from a preliminary investigation, that 200,000 corporations out of a total of 260,000 engaged in the manufacturing and mercantile business of the United States were eking out an existence; 100,000 of them did not earn a penny. Out of 60,000 successful corporations doing a business of $100,000 a year, over 30,000 charged off no depreciation whatever.

"Only ten per cent. of our manufacturers and merchants know the actual cost to manufacture and sell their products; 40 per cent. estimate what their costs are, and 50 per cent. have no method, but price their goods arbitrarily. Most of the manufacturers and merchants who do not know what their goods cost are basing their selling price on what their competitors sell for, and with only this knowledge for a basis they are frequently cutting prices and demoralizing the industry in which they are engaged.

"There were over 22,000 business failures in the United States last year; more than 20,000 of them were

small concerns. We all know that a large percentage of business is run at loose ends, haphazard and without the proprietors really knowing at any time how they stand or whether they are making a profit or a loss."

These are startling facts, but they must be carefully considered, especially when coming from an authoritative source. They, of course, apply to the situation across the border, but the facts may to a large extent be taken as indicative of Canada's industrial efficiency. Assuming such statements as these to be the case and that only 10 per cent. of our manufacturers and merchants know what their costs are, that 40 per cent rely on estimates, while fully one-half have no method at all, it is more clearly realized that scientific cost-keeping is of fundamental importance to commercial success. This principle of efficient cost accounting is the greatest need of the times. To quote Mr. William J. Harris:

"A manufacturer who does not know with a close degree of accuracy what it costs him to produce the different articles he manufactures and what it costs him to sell them, is not in a position intelligently to meet competition and invites business disaster."

There has been something wrong with business; close competition, increasing expense and decreasing returns, are preventing the earning of large profits by easy methods. The only way to make money it by greater efficiency, which, in large measure, means better methods of cost keeping.

Many of the larger manufacturers have arranged thorough cost systems, realizing their need in order to gain essential information regarding successful management. The smaller manufacturers, however, have, as a rule, priced their goods arbitrarily, and this has left openings for the operations of the price cutter, because almost invariably the worst offender in this regard is the man who knows least about his costs. Proper cost accounting is most essential, therefore, for the small manufacturer.

The method of working out a system must be suited to each particular business. The proper application must be carefully thought out. But the point is, that in any kind of business organization, large or small, the installing of better accounting systems will go a long way towards making this country an important factor in the world's market. The essential fact is that in better methods lies our hope of future prosperity.

Town Planning in Canada

Mr. Thomas Adams, town planning adviser to the Canadian Commission of Conservation, Ottawa, writes as follows in a recent issue of Engineering News, regarding the town planning operations of the Dominion:

Town planning in Canada is being placed in the hands of engineers and architects acting in collaboration. The Commission of Conservation is the advisory body for the whole Dominion and has its engineering and public-health experts. Housing and town planning are dealt with as twin problems, and the primary object of all schemes are to secure (1) proper sanitary conditions, (2) convenience for traffic, and (3) amenity or agreeableness in the development of land. Hitherto the owners of real estate have been allowed to plan their land with the sole object of private gain and greatly to the inconvenience of the public. More co-operation is needed in the interests of such owners themselves, and eminently in the interests of the public welfare.

The passing of legislation to give city, town and municipal councils powers to prepare proper schemes is the first essential. Four provinces out of nine in Canada have now town-planning acts, and the other five provinces are likely to have acts on their statute books within another year. Nova Scotia has a compulsory act which requires that the whole province must be the subject of a scheme of planning within the next three years. These schemes have to provide for:

1. Main thoroughfares (up to 100 feet wide).
2. Building lines (40 to 60 ft. from the centre of each street of whatever width).
3. Narrow residential roads of short lengths (24 to 66 ft. according to traffic requirements).
4. Reservation of residential and manufacturing areas.
5. Restriction on extent of lot to be built on and number of dwellings to each acre.
6. Preservation of features of natural beauty and restriction on nuisances, billboards, etc.

The street system of each municipality has to work in with the general highway plan of the whole province. Wide main thoroughfares have to be arranged by "give and take" arrangements with real-estate owners by which complementary narrow streets are permitted in places where traffic requirements are light. Thus these main thoroughfares have not to be made at the cost of the general taxpayer, but by a sensible variation in width under a scheme. Fixing widths of streets by ordinance or by law is always unsatisfactory because such ordinances have to be specific in character and general in their application. Town-planning schemes allow discretion to be used and every street or other feature to be considered on its merits.

Of the schemes under consideration in Canada the largest, and the first statutory scheme to be started, is that of St. John, N. B., which deals with about 20,000 acres, of which half are inside and half are outside the city. Although the application to prepare this scheme carried with it the power of the City Council to restrict real-estate development, and to prevent any owner from contravening the proposed scheme, before it was prepared, only one owner raised an objection and was overruled.

A plan has been prepared by a special commission for the reconstruction and replanning of the capital city of Ottawa. The expert advisers were Mr. Bennett, architect, of Chicago, and Mr. Cousins, civil engineer, of Toronto.

Another development in Canada for which the Commission of Conservation is responsible is the formation of a Civic Improvement League for the Dominion. The object of this League is to educate public opinion so as to use the new town planning powers. A strong engineering committee of the League has been formed under the chairmanship of the Ontario Deputy Minister of Highways to prepare a report on Highways and Transportation. The good-roads movement has also linked itself up with the town-planning movement, so that the planning of highways is being considered side by side with methods of construction.

Mr. J. McGregor, superintending engineer of the Halifax Ocean Terminals, has obtained leave of absence from the Government railway department to join the overseas forces. He is to be chief engineer of the railway construction battalion commanded by Col. J. W. Stewart, with the rank of major.

North Toronto Union Railway Station

Now Open to Traffic — A Handsome Structure Without and Within—Utilizes all the Modern Ideas in Handling the Public

Fig. 1.—One of the special lighting units in the waiting room of the North Toronto Station for use of C. N. R. and C. P. R.

THE accompanying illustrations show different views of the new North Toronto railway station, recently opened for traffic. Fig. 2 is a general view taken from Yonge Street on the south side and shows, on the left, the subway under which the tracks of the Toronto Railway Company will be constructed, the overhead lines of the C. P. R. and C. N. R., the canopies over these lines, the main tower of the station, which is practically complete, and on the right of the figure, the office building and waiting rooms. The new station is a single storey stone (Tyndall) structure. The tower is 140 feet high and will be surmounted by a 30 ft. terra cotta spire. The station building is 114 feet x 75 feet.

The central or high section of the station, as seen on the right hand of Fig. 2, is the main waiting room. This measures 70 ft. x 51 ft. and has a centre entrance from the driveway on the south and two entrances out of the main hall on the north. On the west side of this room are the ticket and telegraph offices, and on the east, women's waiting room, smoking room, lavatories, etc. The south and west sides of the station have metal canopies over the sidewalks. Along the west or Yonge Street side of the station is a 28-foot driveway, which gives easy access either to the baggage room or the waiting room and ticket office.

Back of the baggage room and running parallel with Yonge St., is a midway, 20 feet wide and 14 feet high, this height practically representing the difference in level between the station floor and the track platform. The six overhead tracks pass over the midway and baggage room section of the station building.

Fig. 3 shows the interior of the waiting room. This room, together with the main concourse and the tower entrance, is walled with marble over the entire height. The midway is lined with glazed brick, as are also the staircases leading up to the platform. A special feature of the waiting room is the illumination, shown also in Fig. 3. An enlarged unit is shown in Fig. 1. These units are a combination of direct and semi-indirect lighting and produce a very uniform and restful effect.

To reach the train platforms, passengers must pass through the midway and up one or other of the three staircases. The platforms are 20 ft. 3 ins. wide by 600 ft. long and are covered by butterfly roofs for a distance of 360 feet, which later will be extended to the full length of the platform. The roof is wood on a steel frame supported by steel posts in the middle of the platform. The roof has a spread of 25 feet, and extends well over cars standing on the platform tracks. One view of the platform deck is shown in Fig. 4.

Fig. 2.—General view of new station from Yonge St. south.

The baggage room is 137 ft. x 62 ft., and occupies all the area beneath the tracks between the midway and the Yonge Street driveway. Baggage is received from the driveway through five doorways, as shown, and raised on trucks to the platform level by elevators. Passenger communication with the baggage room is through the main concourse.

The construction work was carried through by P. Lyall & Sons, general contractors. Darling & Pear-

Fig. 3.—A handsome interior—the general waiting room.

Railway platforms have butterfly roofs.

son were the architects. Mr. Blair Ripley, now Lt.-Col. No. 1 Overseas Construction Battalion, had charge of the engineering work for the C. P. R.

B. C. Municipalities Favor Bitulithic

IN Fig. 1 we reproduce a photograph of a section of bitulithic pavement on Dewdney Trunk Road, city of Port Coquitlam, B. C., recently completed by Columbia Bitulithic, Limited, Dominion Trust Building, Vancouver. The section is about one mile in length. It represents a type of permanent country road which is rapidly coming into favor in rural municipalities of British Columbia, where better transportation facilities are receiving a great deal of attention. The roadway shown is without curbs, being laid to wooden header.

Bitulithic pavement is now laid at Saanich, Fig. 2, Vancouver Island, and New Westminster. This class of pavement was also laid at Nanaimo, Vancouver Island, during the present year, which is in addition to extensive improvements of a similar nature during 1915. The cities of Vancouver, Point Grey, South Vancouver and Revelstoke all boast this type of permanent road, while 39 additional cities throughout the Dominion of Canada have adopted bitulithic as a standard pavement.

Fig. 1.—Dewdney Trunk Road, Port Coquitlam.

In all, Saanich municipality will have 24 miles of bitulithic faced roadway when the present construction programme has been completed.

The Dewdney Trunk Road is an example of the gravel bitulithic pavement, while the Saanich Road is constructed by re-surface of the old macadam roadway with a two-inch standard bitulithic carpet, the two types mentioned being among various forms of bitulithic construction.

As indicating the rapid growth of bitulithic pavements Warren Bros. Company recently made the following estimate. The figures apply to Canada and the United States taken together:

Fig. 2.—Bitulithic on Main Road, Saanich, B. C.

Development of Bitulithic Pavement

Year	Cities	Square Yards	
1901	7	16,400	
1902	33	400,831	
1903	40	915,630	
1904	45	1,041,724	
1905	42	1,041,327	
1906	57	1,508,095	
1907	66	1,924,222	
1908	62	1,676,433	
1909	74	2,071,987	
1910	97	3,047,276	
1911	99	4,189,182	
1912	150	4,830,601	
1913	129	5,081,068	
1914	116	4,204,943	
1915	127	4,495,393	
1916	63	2,612,092	Laid and under contract Feb. 29, 1916.
2,219 miles roadway, 30 ft. wide between curbs		39,057,204	

Exports to South America Doubled

Exports from the United States to South American countries were more than doubled during the past year, according to data collected by the Bureau of Foreign and Domestic Commerce.

Fig. 1.—Rosedale section nearing completion.

Fig. 2.—Don section looking west on June 1, 1916.

Bloor Street Viaduct Progress

THE illustrations shown below give an idea of the progress that has been made recently on the Bloor Street Viaduct. Fig. 2 shows a general view of the Don section, looking west from Danforth Avenue, and Fig. 1 illustrates the Rosedale section, looking south.

On the Don section, as can be seen, the steel work is well started on the east or Broadview Avenue side, one arch being practically complete. The west side has the steel approach work finished, but none of the main arches have been started. The substructure is all in. The cut shows clearly the five wooden towers by means of which the concrete is raised in buckets to the steel hoppers and thence distributed by gravity through steel chutes to the points required. All the concrete was poured in this way. An aerial railway is seen extending from the tower near the right of the photograph to the hill in the background. This cable way is 1,200 feet long and carries a travelling bucket for the distribution of all excavated material, aggregate, and concrete. The type of arch adopted is clearly shown. The steel work on the immediate left will be encased in concrete, that is, with concrete side walls and suspended ceiling arches. This will give the impression of a single massing abutment.

The Rosedale section, shown in Fig. 1, is 600 feet long. The steel span illustrated is 190 feet. The frame work is practically finished and work is continuing on the cement piers. The arches on either side will be encased in concrete, as described above for the Don section. On this section concrete was poured in the same manner as for the Don portion—from two large wooden towers, one on each bank. Considerably more difficulty was experienced in constructing this section than the Don section on account of hauling the materials instead of distributing them by cable or dump cars.

The main piers of the bridge rest on bed rock, while the lesser ones have spread footings on hard dry clay.

Engineers Will Investigate, Gratis

The question of the enlargement of the Montreal aqueduct and the hydro-electric development has undergone another change, and there is now strong evidence that the scheme will be investigated. The Council of the Canadian Society of Civil Engineers and other bodies requested an independent investigation, but the city council refused this. Subsequently a special committee of the council appointed in May, 1915, reported that they had carefully considered the request of the Canadian Society of Civil Engineers, and were of opinion that the members should be allowed an opportunity of studying the plans, provided that the city be not called upon to bear any cost or to pay any fees, the committee being of opinion that "the Society is actuated in the matter solely by public spirit and have no pecuniary interest in view."

Members of the Society had previously offered to do this work free, and it is understood that they will willingly make the investigation on the conditions suggested by the committee and endorsed by the council. They have repeatedly stated that they have no personal interest in the matter except as a body of engineers and taxpayers; that the scheme, on the surface, appears to be costly, as compared with hydro-electric development of public utility corporations; that the project as a whole has not been reported on by disinterested engineers; and that the Society's council, while not criticising the project, believed that further study was necessary before proceeding with any additional expenditure. An investigation will show how far the claims of the city engineers that the plan is economically sound, and the contention of other engineers that it is extravagant and not likely to give the estimated power, are justified.

In connection with the enlargement of the aqueduct, the Cook Construction Company has sent to the city council a bill for $908,000, of which $452,000 is for claims. The three principal items of the latter amount are $123,000 for loss of reasonable profits owing to various delays and hindrances; $133,000 for reclassification, and $157,000 for overbreak excavation. The city is informed that the figures are not final, as the claims increase concurrently with the progress of the work. In addition to the claims, the company is asking for the payment of $455,000 made up of various amounts for work done under the contract. It is stated that the work was held up, owing to the company not having access to the land, the plant thereby being tied up. It is proposed to arbitrate the differences between the company and the city, it being stated by Controller Cote that the city has a counter claim.

Intensive Street Cleaning Methods

Description of a Scientific System Applied in Chicago—A High Standard Developed—Continual Cleaning Necessary

THE question of street cleaning is one of the most important of civic problems. From a health or sanitary standpoint alone, a high degree of street cleanliness is essential, and it should be the duty of all citizens to maintain as high a standard as possible in keeping their streets clean, not only for the good appearance of their city, but for the safeguarding of their own health. Some ten or twelve years ago a number of public-spirited citizens in Chicago, realizing the low standard of cleanliness in that city, when the amount of money appropriated for street cleaning purposes was very small, organized and financed a Citizens' Street Cleaning Bureau. This bureau makes a study of street cleaning methods with the object of developing and maintaining a system that will most effectively keep the city clean. It has developed certain standards by a thorough study of refuse distribution, of time elapsing before collection from the street, and of other factors in hand-sweeping operations in the central business districts of Chicago. This study, under the title of "Intensive Street Cleaning Methods," forms the subject of a paper delivered before the Western Society of Engineers by Mr. Richard T. Fox, general manager of the Street Cleaning Bureau. Abstracts of Mr. Fox' paper are given in the following paragraphs:—

A standard of street cleanliness, so far as I know, has never been defined. At least there is no record of it.

Two people will disagree as to which of two cities has the cleanest streets. If there is no prejudice in the minds of either, they may both be right, for their conceptions of what constitutes a clean street may differ. In other words, their standard of cleanliness is not the same. A standard of street cleanliness, then, is a question of individual opinion.

In connection with our work in Chicago downtown streets, we have attempted to create a standard of cleanliness which is a matter of fact—a standard that can be defined and checked.

In order to make clear what is meant by our standard of cleanliness, it is necessary to consider the character and distribution of street refuse and the method of removing it from the streets.

How Work is Apportioned

The process of cleaning the streets is carried out in two operations—one, the collection of the refuse from the streets; two, the removal of the material to the points of disposal.

The latter is a simple transportation problem, involving the hauling of certain quantities which vary somewhat from day to day from definite points, definite distances to the points of disposal. The factors affecting the amount of work a cart, wagon, motor vehicle, or other unit, can do per day, can be measured and a definite standard of work set up. The quantity and quality of work can be readily checked.

The collection of the refuse from the streets presents a different problem, the solution of which is more involved, as to a determination of standards of work and the quantity and quality of work.

It will be necessary to make clear the conditions under which the dirt appears on the street before considering the quantity and quality of work.

The street refuse is accumulating through every hour of the twenty-four and varies from a fraction of one cubic foot per 1,000 square yards of street pavement per twenty-four hours, on streets of the lightest traffic, to ten or more cubic feet on streets of the heaviest traffic. The proportion of the dirt appearing at night, or say from 5 p.m. to 7 a.m., is naturally light, varying from nothing to a maximum of 20 per cent. of the 24 hour output.

These quantities and likewise their character and distribution vary from day to day, and even from hour to hour for the same 1,000 square yards of pavement.

Street Refuse is in Two Forms

Refuse appears on the street in two forms: As fragments of various sizes, and as fine dust. For convenience, the former will be referred to hereafter as dirt or refuse, and the latter as dust or residual dust.

If a street is given anything like the daily attention it requires, the dirt appearing on its surface through the day will lie in detached deposits here and there with clean spaces of pavement between them. It is not necessary, then to clean the entire street, but simply to remove the individual deposits of dirt.

Hand Collection Principles Defined

The demands of a proper removal of this refuse from the street surface require the observance of two principles:

1. That the dirt be picked up at or as near as possible to its point of origin in the street.

It must not be pushed in front of a broom or scraper and smeared over clean spaces of pavement to the curb, or until the accumulation has reached a point where it must be picked up. Less labor is required if it is swept into shovel or scraper just where it lies. The cleaning operation on each deposit of dirt must be so thorough that no noticeable particles are left behind to dry out and to be pulverized by traffic.

2. That the refuse be collected as near the time of origin as possible.

If it is left in the street over a certain limit of time, which will vary with the amount of traffic in the street, the papers and light materials will be scattered by the wind and the heavier dirt will be tracked and spread over the pavement by passing horses and vehicles and embedded in the furrows of open joint pavements or smeared over and pasted to the surface of smooth pavements, all of which adds to the expense of finally removing it. Furthermore, if left too long, the dirt dries out and is ground into dust, which is blown about the street—an annoyance and discomfort to pedestrians and a cause of damage to furnishings in houses and to merchandise exposed for sale inside and outside of markets and stores.

If the dirt is thoroughly collected just where it lies and while it is still moist, no dust will be raised during the operation.

Ever Present Fine Dust is an Annoyance and Danger

If the two principles noted above are vigorously and intelligently applied through the day, there will remain on the street, after the day's work is complete,

a very fine dust, the quantity of which will depend on the fineness of the broom used in the day's work, and the thoroughness of the cleaning.

This residual dust is the greatest annoyance and nuisance with which the street cleaning forces have to contend, and as a medium for disseminating disease germs it is a menace to health.

It is very difficult to manage, because it is appearing every moment on the street from such sources as the thousands of chimneys, the roofs of buildings, disturbance of street pavements, the fine sand used by the street railway companies, the wear from pavements, sidewalks, wheels, street car rails, etc.—all of which are without the control of the street cleaning officials.

Quantity and Composition of Dust

I have attempted in Chicago to separate the sources of dust found in the street and to determine the composition and quantity of the dust from each source, but so far the results have not been entirely satisfactory.

The information contained in the following table is interesting as showing the quantity of dust per thousand square yards of surface and its composition and its distribution over the street. The street on which this particular test was made is paved with creosoted wooden block and carries a double car track, which is paved with the same material except for two rows of granite block along the outside of the outer rails. The sidewalks are of cement. The traffic is heavy, as indicated by the accumulation of dirt, 8 cu. ft. per 1,000 sq. yd. per 24 hours.

After collecting the heavy material, the dust from the sidewalk, the roadway (from the car tracks to the curb), and from the car tracks, was collected with horsehair brooms and measured separately and samples of each accumulation were submitted to a chemical analysis on a dry basis.

From this data the following table was obtained:

	Sidewalk Lbs. Dust per 1,000 sq. yd.	Roadway Curb to car tracks Lbs. Dust per 1,000 sq. yd.	Street Car Right of Way Lbs. Dust per 1,000 sq. yd.
Silica	0.96	4.70	50.50
Carbon and organic matter	.67	3.00	26.00
Calcium carbonate	.20	.60	6.00
Magnesium carbonate	.02	.30	2.30
Iron	.11	.25	3.00
Undetermined	.04	.15	.20
	2.00	9.00	88.00

Composition of Street Dust

The silica consists mainly of dirt from the street, sand and gravel from the roofs of buildings, leakage from vehicles, and the fine sand used on the car tracks to facilitate the stopping of cars.

The organic matter and carbon consists of refuse paper, manure, soot, coal, and various other volatile matters commonly found in the street.

The carbonate of lime is principally from the limestone, spilled from vehicles conveying building materials, etc., and likewise most of the carbonate of lime found in the dust from the sidewalk is from this source, although some of it is from the wearing down of cement sidewalks by pedestrians.

The iron content exists in the free state and the natural assumption is that most of it comes from the car tracks, although some of it is from the wheels of vehicles, and from the shoes of horses and even of pedestrians.

It is interesting to compare the quantity of dust collected from a street carrying car tracks with the quantity collected from a street without car tracks. For purposes of comparison the same classification as to the sidewalk, roadway and car tracks is maintained—a space 16 feet wide through the middle of the street representing the car tracks, in the case of the street without car tracks.

	Sidewalk Curb Lbs. Dust per 1,000 sq. yd.	Roadway to car tracks Lbs. Dust per 1,000 sq. yd.	Street Car Right of Way Lbs. Dust per 1,000 sq. yd.
Street with car track	4.30	6.00	90.00
Street without car tracks	4.00	9.60	2.60

Street Cars Make Dust and Car Tracks Collect It.

The proportionately large quantity of dust collected from the street car tracks is due to (1) the excessive amount of fine sand used on the street car rails; (2) the fact that the grooved rails and other breaks in the continuity of the street surface within the car tracks catch and hold the dirt and dust; (3) the difficulty of cleaning the grooves and the space between the rails in the daytime because of congestion of traffic. This indicates the necessity for sprinkling, especially the car tracks.

The total quantity of residual dust, if spread evenly over the whole surface of the street would amount to .15 of an ounce per square foot of street surface, which, of course would hardly be noticed unless the wind is blowing, or a fast moving motor or street car passes over it.

How Dust is Removed

Any system of street cleaning, to be effective, must provide every means possible, such as artificial sprinkling, flushing the streets and even scrubbing them, to combat the evil of fine dust. I find the most effective method and means of routing the dust is to flush the streets at night with a motor driven machine carrying a large tank from which the water is forced out under any desired pressure, up to 70 lbs., by a pump driven from the flywheel of the motor. Following this operation the sidewalks are flushed and hand squeegeed and finally the gutters are washed and squeegeed to remove any dust from the roadway or sidewalk collected in low places there.

When the weather does not permit of flushing, the noticeable deposits of dust are collected by men cleaning sidewalks. These men are provided with horsehair brooms, by careful use of which they can collect the dust without causing a nuisance by setting it astir.

Quantity of Work

The quantity of work—the square yards of street pavement a man can clean daily—will depend not only on the refuse accumulations per thousand square yards per 24 hours, the kind of pavement—whether rough blocks with open joints, or a continuously smooth surface, condition of pavement—whether in good repair or not, but on the quality of work—whether thorough or not—and on the standard of cleanliness.

The first three factors are definite matters of fact. The remaining two have so far been considered questions of opinion, and have not to my knowledge been defined.

Quality of Work

The quality of work is a very important consideration, for a street surface not thoroughly cleaned can-

not be called clean. If the horse droppings are carelessly picked up, if the dirt in the crevices and depressions of the pavements is not thoroughly removed; if, in fact, every bit of detachable refuse is not collected, the street has been merely brushed over, and the condition of the pavement falls far short of the aims of proper and sanitary street cleaning.

How Quality of Work is Measured

Theoretically, the measure of the quality of work is the quantity of material remaining on the streets after the day's work is complete, less any accumulations after the beginning of the sweeper's last trip over the street. But, as pointed out, there is always on the street at the end of a day's work a certain quantity of fine dust which cannot be collected by the means at the sweeper's disposal. This quantity varies from day to day, which is due to a number of factors not under the control of the sweeper. Therefore, unless there is a very noticeable increase in the residual dust, it is difficult to determine whether or not the sweeper is at fault.

Furthermore, there might be enough undigested portions of hay, oats, and other feed, and bits of paper, together with matches, cigars or cigarette butts, and other noticeable odds and ends, scattered over the street to give it an untidy and unsightly appearance; and yet the total quantity of these would affect but little the amount of residual dust on the street.

Practically, then, this test for quality is not, as a rule, feasible. The practical day to day determination of this element of the work is by the eye of trained and experienced inspectors, who are alert and observant.

What is a Standard of Cleanliness?

When we say a street is clean, what do we mean? In other words, what is a clean street?

Absolute cleanliness, the ideal condition, means that a street must be continuously free of dirt and dust. This condition can be maintained as far as the heavier fragments of street refuse are concerned, but the cost would be prohibitive. Moreover, it is not necessary, for this dirt is not objectionable, if removed before it dries out, or is scattered and ground into the pavement by traffic. The length of time it can be left on the street will depend upon the amount of the twenty-four hour accumulation per thousand square yards of street surface; or, in other words, on the volume and kind of traffic.

The residual dust from one or the other of many sources, although it may be hardly perceptible, will always lie on the street. Therefore, absolute cleanliness is an impossibility and will continue to be so until the sources of dust beyond the control of the street cleaner are eliminated.

The length of time any refuse other than dust is permitted to remain on the street will determine the standard of cleanliness for that street.

A standard of cleanliness, then, is an arbitrary matter, but it can be made definite for certain conditions of traffic, etc., by specifying the length of time any refuse other than fine dust can remain on the street.

Details of the Intensive Method

In the conduct of the work of the Citizens' Street Cleaning Bureau, we have developed in following closely the hand collection principles stated heretofore, what may be called the intensive method of street cleaning. The aim of this method is not only to clean a street thoroughly, but to keep it continuously clean throughout the working day.

The street sweepers are assigned a definite length of street, called a route, to care for as in the "patrol" or "block" system of street cleaning. The men are required to clean thoroughly their routes in the first hour of work in the morning, and thereafter to keep the refuse picked up practically as fast as it reaches the pavement. In other words, the work is not allowed to accumulate, but is taken care of as it presents itself.

It is apparent that to do this the number of cleanings or trips over the route formerly given under the block system must be greatly increased. This increase is expressed in the statement that the standard of work under the "block" system is based on a certain number of cleanings per day, while the intensive method requires a certain number of cleanings per hour.

The advantage gained in the latter method is that for the same street area cleaned and the same amount of dirt collected the length of time the dirt lies in the street is greatly decreased by reason of the added number of cleanings and therefore a much higher standard of cleanliness is obtained.

Suppose a street is cleaned only once per day, then the dirt and refuse would be cumulative and the actual position of the material would not be in individual spots. The sweeper would find it spread over the entire street and adhered to the pavement by the action of hours of heavy traffic and he would be compelled laboriously to sweep with a hand broom every square foot of the surface to clean it thoroughly. The distance walked by the sweeper in the course of the day's work would be at least 4.3 miles, which means that he must sweep a like distance, as this act is continuous throughout the day.

If the route is cleaned once each hour, no deposit can remain more than one hour at the most without collection, and the average will be but a few minutes. The deposits of dirt will have clean spaces of pavement between them, for it will be scattered by traffic but little, when the route is cleaned as frequently as we are assuming it to be.

The sweeper can now use, in addition to his broom, a pan scraper, which permits of more rapid and easier work than a broom alone, and as he can collect each deposit where it lies without cleaning the entire street, a trip over the route is rapidly made. The distance now walked is a minimum of 6 miles per day of 10 hours; therefore, the distance has increased and the labor of sweeping has been lessened.

Now, if the route is cleaned, say, seven times in an hour, no spot remains unswept more than a very few minutes. An intensive study of one particular downtown route for one hour showed that on one trip no dirt was collected at all, and the greatest number of pick-ups on any trip was six. Therefore the sweeper is able to clean the street about as fast as he can walk and the work is accomplished much less laboriously than in each of the other instances.

The route in question was swept on this particular occasion 90 times, the sweeper walking a minimum distance of eight miles in 10 hours. That is to say, the sweeper has shifted a considerable part of his daily burden from his arms to his legs. The total physical effort is no greater than in the other instances.

The streets cleaned by the Citizens' Street Cleaning Bureau produced from five to eight cubic feet of street refuse per 1,000 square yards per 24 hours. On streets of lighter traffic and therefore accumulating less dirt, the street areas or routes allotted per man would naturally be increased. In such case, if the streets are the same width, a sweeper would have a greater length of street to traverse and would accord-

ingly make less trips per day. The length of time elapsing before collection would be increased. In other words, another time standard must be established for the new conditions.

Many Short Periods of No Dirt

It is interesting to note that the study showed that there are many short periods when the street was entirely free from dirt. These clean periods average 3½ hours per day for the entire district cleaned. An intensive study of the route referred to showed that, excluding the first hour of work, and that following the noon hour, 48 per cent. of the total pick-ups were made within one minute, 72 per cent. within two minutes, 94 per cent. within six minutes, and 97 per cent. within ten minutes. Tests made on all the routes cleaned by the Bureau show that under our system of work it is easily possible to collect every deposit of dirt, other than at the hours noted above, within 15 minutes of its appearance on the street.

The standard of cleanliness, then, for our streets, under existing heavy traffic conditions, is that the street shall be thoroughly cleaned and that no dirt other than excepted and the fine dust shall lie on the street over a maximum time of fifteen minutes.

While our standard of cleanliness is defined and can be readily checked within close limits, and is checked by actual observation and test from time to time, the day to day determination of this factor is by the eye of the foreman. The standard of cleanliness is so fixed in the minds of the foremen that they can tell at a glance whether or not a sweeper is abreast of his work.

Cost of Maintaining Standard Defined

The standard of cleanliness here defined is maintained in but few cities anywhere, so naturally the question may arise as to the cost of maintaining it.

The variation in wages paid labor, hours worked, cartage costs, etc., in different cities, would take the meaning out of the figures I would submit. The best way I can answer the question is to make a comparison between what individual men are doing here with what they are doing in New York under similar conditions.

There is no section in New York the exact counterpart of the "loop" in Chicago. The nearest approach to the same traffic conditions is the first district, which is that portion of the Borough of Manhattan south of Canal street. Making allowance for the proportionately greater area of granite in New York, the comparison would stand as follows:—

	Area cleaned per man sq. yd.	Times cleaned per day	Cu. yd. of dirt per 1,000 sq. yd. of pavement per year
New York City	3,250	5 or 6	56
Citizens' St. Cleaning Bureau	3,000	56	80

The areas cleaned per man do not vary greatly. The times cleaned per day in Chicago are ten times greater than in New York. In other words, the dirt lies on the street in Chicago only one-tenth the length of time it is allowed to lie in New York. The amount of dirt collected is fifty per cent. greater than in New York.

The standards of cleanliness and the quality of work being specified, a block-by-block survey of the quantity of refuse accumulating per twenty-four hours, the kinds of pavement, the condition of pavement and other factors affecting the amount of work a sweeper should do as a daily task, will furnish the information for the uniform allotment of work for every type of conditions.

Frequent and thorough inspections must be depended on to obtain daily the quality of work and to maintain the standard of cleanliness.

In fact, if the work is fairly proportioned to the individual laborer and he is carefully instructed in his duties, the proper cleaning of the streets resolves itself into a matter of a thoroughly instructed and disciplined organization continuous in its management and of adequate and trained inspectors.

A standard of cleanliness, then, for a city, will depend not only on the amount of money appropriated for street cleaning, but on the ability of the head of the street cleaning forces to apportion the work to the individual to the best advantage and to build up an organization that is efficient in supervision, inspection and in thorough cleaning.

Preparation of Bills of Quantities

By R. O. Wynne-Roberts

IN ordinary business pro forma invoices accompany quotations for goods and services, so that the seller and the buyer know what are included in the proposed transaction. Before this can be done, the buyer must decide what he wants the seller to quote for, and the more definite the instructions are, the more satisfactory will the quotation be.

When we consider what is done in connection with many structural undertakings, it would seem somewhat anomalous that the foregoing practice is not observed. A certain work has been designed by an architect or an engineer Tenders are invited for the execution of such work, but the contractor must often ascertain as best he can what amount of work is involved. Drawings are exhibited and specifications are shown, but the schedules of various work to be done are either inadequate in detail or the contractor is left to work out the necessary statistical information for himself before he can be able to submit a tender. When this occurs in connection with reinforced concrete, which appears to many as a much more complex undertaking, it is difficult to understand how contractors can build up their estimates. But reinforced concrete specialists do issue quantities although not always prepared by a standard method.

It would appear that the preparation of schedules of quantities by engineers and architects in connection with reinforced concrete work is often considered to be too abstruse an undertaking to warrant the trouble and expense. Quantity surveying in Britain is a profession which is old and respected, but in North America it has not yet been firmly established, but there is a movement in that direction in the United States.

It requires some weeks to prepare drawings and specifications of some reinforced concrete work and when tenders are invited contractors are expected to digest all the data, to study the drawings, to reconnoitre the district, to collect the particulars which are local in character, etc., in a few days, and often to compile his own bill of quantities. Under such con-

ditions the contractor must, perforce, make ample allowance for contingencies which may or may not arise.

Specifications which are loosely drawn or drawings which give inadequate information, afford excellent opportunities for future claims and troubles.

It is probable that even with scrupulous care and infinite pains, it is rare that extras of some form are entirely absent. It is almost superhuman to expect such perfection, because, be the plans ever so well

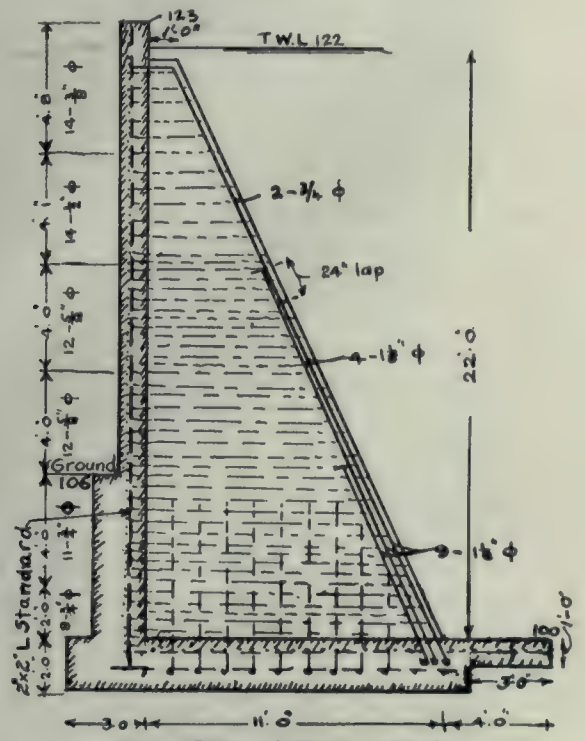


Fig. 1.—Section of wall and counterfort.

prepared, the engineer or architect can during construction discern where improvements in design or change of materials will be to the client's benefit. Moreover, the contractor is able to put forward suggestions which are worthy of careful consideration by the architect or engineer or client.

It is in the interest of both the architect or engineer, the contractor and the client that regard should be paid to the method by which contracts are let, certificates are granted and adjustments are made.

Lump sum tenders would at first sight appear to be an easy and desirable way of letting contracts. The architect or engineer has before him the tangible figures as to the cost. The contractor has given thought to all contingencies and has assessed the value of all anticipated risks and provided for his profit. The client knows what amount he will be called upon to pay. Much depends upon the persons concerned in such a contract and the care which has been taken in the preparation of the plans and specifications, in the pricing of the contract and in the selection of the contractor as to the extent mutual satisfaction will be enjoyed.

Modifications of and additions to the contract must be adjusted and some basis should be fixed upon for their settlement. If a schedule of prices has been filled in for various classes of work, then it will constitute such a basis, provided, however, that the prices are balanced. For example, a lump sum tender was sent in, accompanied by a priced schedule, for the construction of a reinforced concrete reservoir. The prices given in the schedule were not those by which the tender was built up, and moreover, some of the prices were exceedingly high in some cases. Nine trial holes about 6 feet by 4 feet had been sunk on the site to depths varying from 20 to 30 feet to ascertain the nature of the foundations. No rock was found. The successful tenderer had studied the contract and examined the trial holes. His price for rock excavation was very high, but as no rock was met with, no question was raised. When the actual excavations were in hand, a considerable quantity of rock was revealed and the contractor benefitted thereby. His tender was really too low, but the fortunate occurrence of rock helped him materially. Unbalanced bids, however, are not desirable, they are too speculative. They should be carefully examined and, if possible, adjusted before tenders are let. Otherwise they may lead to unpleasant difficulties.

The schedule of quantities should be an analysis of facts presented in ordered form. They will help to obviate the thorny points referred to.

The experience of generations has crystalized the various ways of measuring up buildings or plans and presenting the facts into a few recognized standard methods. This applies to the older forms of building construction In connection with reinforced concrete work, however, the methods have to be changed and the presentation of the ascertained facts have to be expressed in a different manner. Reinforced concrete structures comprise many variations in the application or combination of materials, methods of reinforcing, etc., although during the last twenty years many unnecessary variations have been abolished by common consent. In some instances, even at the present time, there are often too many variations in qualities of concrete, in dimensions of steel bars, etc. These tend to render the measurements somewhat complicated to abstract and also increase the work of the contractor and the supervising officials. In the construction of a reservoir, for example, it is necessary to have rich concrete to provide for water-tightness and leaner concrete can be used where circum-

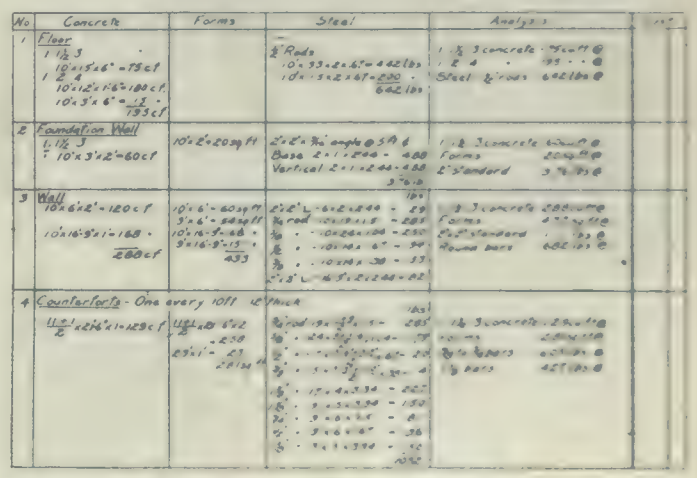


Fig. 2.

stances warrant the same. As the water pressure varies with the depth so must the quantity of steel, but it is possible to confine the dimension to those usually stocked. The writer's practice has been to vary the diameter by eighths of an inch. This can be done by regulating the spacing.

The method of abstracting the quantities might be described. Mr. E. P. Wells' method was adopted by the writer which is a simple and an effectual one.

It constitutes a permanent record and any part of the work can be re-measured and compared at will. A sheet of ruled paper was used as in Fig. 2.

For the purpose of illustrating the method of measuring up reinforced concrete work, a small part of a reservoir wall and floor as shown in the rough sketch, Fig. 1, will be worked out. The floor is of 1:2:4 concrete except the top layer, 6 inches thick, which is of 1:1½:3 concrete. The floor has ½-inch bars laid 6 inches apart in two directions and under the counterfort portion, ½ inch bars at 12 inches in two

No		Quant.	Unit.	Unit Price	Cost
1	Floor				
	1:1½:3 concrete	75	cu.ft		
	1:2:4 "	195	"		
	Placing " -labor	270	"		
	½" steel	642	lbs.		
	Labor placing steel	642	"		
2	Foundation of Wall.				
	1:1½:3 concrete	60	cu.ft		
	Labor placing concrete	60	"		
	Forms and labor	20	sq.ft		
	2" standards, placing	10	lbs.		
3	Wall				
	1:1½:3 concrete.	288	cu.ft.		
	Labor placing concrete	288	"		
	Forms and labor	433	sq ft		
	2" standards	111	lbs.		
	⅜" to ¾" round bars.	682	"		
	Labor placing steel	793	"		
4	Counterforts.				
	1:1½:3 concrete	129	cu ft		
	Labor placing concrete	129	"		
	Forms and labor.	281	sq ft.		
	⅜" to ¾" round bars	605	lbs		
	1⅛" round bars	427	"		
	Labor placing bars	1032	"		

Fig. 3.

directions. The wall and counterforts are built of 1:1½:3 concrete. There is a 2 x 2 x 3/16 angle iron standard with holes punched at the required spacing. The horizontal bars and tension bars are as stated on the sketch. The vertical bars connecting the counterfort to the floor are ½ inch rounds. The sketch is submitted simply for illustrative purposes.

The form shown in Fig. 2 shows in tabulated form the method of abstracting the quantities for the structure illustrated, a section of the reservoir wall, 10 ft. long, being considered. The next step is to present the information in the form of a bill of quantities as is done in the form shown in Fig. 3. To show the application of these principles in an actual case, Fig. 4 is a copy of a page of the schedule of quantities prepared in connection with the reservoir described in the Contract Record of March 3, 1915.

The figures in the form shown in Fig. 4 are submitted merely to show how the quantities were obtained and presented for the use of the contractor. As it was afterwards decided to carry out this work by the department, it was possible in many instances to compare the estimated cost with the actual. As was stated in the article on March 3, 1915, the work cost about $30,343, less than the estimate. The estimate, of course, included an allowance for contractors' profit and contingencies.

It is a matter for the engineer or architect to decide to what extent the quantities are to be dissected. If they are added together it will not be so easy to make future comparisons to the same extent as when the details are dissected as shown in the previous examples. Some labor is, of course, involved, but it was thought worth while. On the other hand, as some contractors may not be accustomed to having the quantities priced on these lines, each case must be considered on its merits.

The contractor needs to know many things in connection with a projected work before he can submit an intelligent and reliable tender. It is as much in the interest of the architect or engineer as it is in that of the client and the contractor that it is clearly understood what is included in the tender, how the work has to be executed, the quality of the materials and the workmanship to be employed, the manner in which payments are to be made and accounts are to be adjusted. If the bill of quantities is to be of service all these should be concisely and clearly defined, so that the contractor can concentrate his attention on the important work of pricing. The bill of quantities should furthermore, no doubt, be the basis of contract, and as soon as this is the accepted practice, the contractor will be relieved of much anxiety, the architect or engineer will have the work done in the way desired without much trouble, the client will know that he receives full value for his investment, because prices will not be inflated to meet unknown hazards.

The preparation of the bill of quantities, however, should conform to certain established rules. When the structure is a plain, straightforward, piece of work, such as a rectangular reservoir, geometrical measurement will apply, but when the structure is a warehouse with a multitude of doors, windows and other openings, etc., it is then a question whether the work should be measured solid or deductions for openings should be made. The work of such a building would not be a simple one to estimate. There would be considerable waste in cutting for the openings, especially if the openings are not of uniform size and position. If geo-

No.		Quant	Unit	Unit Price	Cost					
1	Excavation	10126	c yd	25 ct	$2531	50				
	Cartage	10126	"	50 ct	5063	00			$7594	50
2	Floor									
	1 2 4 concrete	30505	c ft	26 ct	7931	30				
	1 1½ 3 "	19075	"	34 "	6485	50				
	Labor placing concrete	49580	"	37 "	1834	46	$16251	26		
	Mesh Reinforcement	95944	lbs	4 ct	3837	76				
	⅜" round bars	44600	"	2.3 "	1025	80				
	½" " "	2830	"	2.4 "	67	92				
	1⅛" " "	660	"	2.3 "	153	18				
	Labor placing mesh reinforct	95944	"	0.25 "	239	86	5084	66		
	" " bars	54090	"	0.6 "	324	54				
	Bending, cutting, etc				200	00				
	Waterproofing	37750	sq ft.	2 ct			764	40		
							755	00	22835	32
3	Walls									
	1:1½:3 concrete	34550	c ft	34 ct	11747	00				
	Labor placing concrete	34550		56 "	1934	80				
	Forms and labor	34550		138 "	4000	00	17681	80		
	¾" round bars	23814	lbs	23 ct	547	72				
	⅝" " "	20612	"	23 "	474	08				
	½" " "	10068	"	2.4 "	241	63				
	⅜" " "	5078	"	2.55 "	129	49				
	2" standard	16464	"	3 "	493	32				
	Wire				30					
	Mesh reinforcement	18190	"	44 "	800	36				
	Labor placing steel	76036	"	0.6 "	456	22	2717	20		
	" " mesh reinforct	18190	"	0.25	45	47				
	Bending, cutting, etc	40000	"	1	400	00				
	Punching holes in standard	36920		—	51	00				
	Waterproofing	19200	sq ft	2 ct			952	69		
							384	00	21736	69
		Carried forward							$52186	51

Fig. 4.

metrical measurements are to be made, without any allowance for custom, practice or condition, it will not matter much, so long as it is clearly known how the measurements are made. But if bills of quantities are prepared according to the individual idiosyncrasies of the architect or engineer, without ample explanation as to the methods employed, then the contractor will doubtless prefer to follow the old, even if it is an unsatisfactory way.

Standard Units for Municipal Improvements Required as a Basis of Comparison

By A. Prescott Folwell *

TO the majority of city officials and taxpayers the one thing most readily understood about public work is its cost. Even engineers, to whom the technical and construction sides of such work are those of most interest, must also consider cost, and consider it most carefully. Not only because the closeness of agreement between their estimates and the actual cost is taken by many citizens as a measure of their ability; but much more because of the real practical importance of such close approximation.

The importance of close estimating is very apparent. If an estimate is excessively high, it may cause the voters to defeat a proposed improvement at the polls. If it proves to have been too low, the voters will be suspicious of all future estimates and may for that reason reject future improvements. Also, bond issues based upon low estimates place the city administration in an embarassing position.

Estimates Based on Past Work

Estimates must be based upon the cost of past work—I know of no other reliable method of estimating. And this means exact knowledge not only of how much was spent, but what was obtained for it. Unit costs are necessary for making estimates.

As to unit costs of work done, any taxpayer feels that he can understand dollars and cents, even though he may be hazy about paving materials and the methods of laying them. When, therefore, he learns that some other city is getting a certain kind of pavement at considerably less cost than his own, or that he is assessed more per front foot for a pavement laid on his street than his neighbor is for the same kind of pavement laid on another street in his city, he wants to know why and is entitled to a clear and definite answer.

There always is an answer, and it is generally a perfectly valid one; but the mere fact that explanations and excuses are necessary is apt to arouse suspicion, especially if there is anything indefinite about those given. How much better if explanations were unnecessary, or if, when required, they could be made so clear and concise as to convince any man of average intelligence.

Why taxpayers might have an excuse for asking explanations and why engineers may have difficulty in making estimates based on costs may be made clear by a few illustrations taken from our own state.

Particular Examples

Take sheet asphalt, for instance. The method of constructing this is standard and there should be no great difference between the costs of it in several cities in the same section of the country. But in 1915 this pavement cost Geneva, N. Y., $1.25 per square yard, and Troy, $2.23. It looks as though Troy taxpayers had some explanation coming to them.

Syracuse paid $1.87 in 1914 and $1.99 in 1915—or increase of 12 cents. But Albany paid $2.14 in 1914 and only $1.74 in 1915—a decrease of 40 cents. What is Syracuse's explanation?

Or take brick pavements. In 1915 Dunkirk laid these for $1.39 a square yard, while Troy paid $2.85—more than twice as much. Syracuse paid $2.05 in 1914 and $2.37 in 1915—an increase of 32 cents; while Salamanca paid 36 cents less in 1915 than in 1914, or $1.89 as compared with $2.25. I have no figures for Buffalo for 1915, but she reported for 1914 a cost of $3.29 for brick pavement—nearly two and a half times as much as Dunkirk; and $3.53 for asphalt, or nearly three times as much as Geneva.

One thing is sure—there was not actually all this difference in costs, and it is evident that these figures are for some reason not comparable—that the thing which Buffalo calls paving is not the same as that to which Dunkirk applies that name. And what Syracuse did for $2.05 in 1914 was not, I believe, the same as that for which she paid $2.37 in 1915.

As Buffalo is the most "horrible example," let us see what she paid $3.53 for in 1914. Included, beside the pavement, some grading, setting new curb, laying a drain, probably other general work like resetting manhole heads, and a 10-year guarantee. Another city, not in this state, has gone far ahead of this, however, for she includes under the head and price of paving, all excavation, curb, storm sewers, adjusting manhole heads, building catch basins and even grading the private property along the street. I see no reason why that city did not include lighting standards, wire conduits, shade trees and other street accessories, except that perhaps they were already in.

Non-Paving Items

All these things are street improvements, but they are not paving, and to call them so seems absurd.

Moreover, to explain that a certain cost includes grading and setting curb does not help us to compare this cost with another—it only shows that such comparison would be useless, unless we know just what part of the cost was to cover each of the non-paving items.

The total cost of these non-paving items may be considerable. For instance, in 1915 Walden, N. Y., laid a brick pavement which cost $1.84 for the pavement and foundation, but $2.34 if excavation and other improvement items be included. This is an average and not an extreme case. In some cases the additional items will amount to even more than the paving.

It may be claimed by some cities that under their methods of assessment the property owner is to be assessed for the total cost of the improvement, and therefore this is the cost desired. This is all right, if you call this street improvement and not paving. But even in this case, itemizing costs is of great value, as will be shown in a minute; and if the cost were itemized, a school boy could get the total cost per front foot in five minutes by a little multiplication and addition; while if the bids or records give only the total cost, not even a paving expert can "unscramble the eggs" and tell what the paving alone cost.

Some prefer a "lump sum" bid, so that no extras can be worked in on the payment. But the same end can be reached by receiving itemized bids, and adding

* Before the 7th Annual Conference of Mayors and other Officials of the State of New York.

a "residuary item" clause, asking a price for all work necessary to complete the job according to plans and specifications, but not covered by the other items.

Costs

The advantage of having bids or costs for each is, I think, apparent with a moment's thought. If we know what it costs each city in the state or in the country to lay a square yard of standard brick pavement, exclusive of excavation, curbs or any other items, then we have figures which are directly comparable. We can tell whether neighboring cities really did get more for a dollar than we did. We can show the taxpayers, without dubious explanations, that they are getting more for their money this year than they did last. If A complains that his street improvement assessment is higher than that of B who lives on the next street, we can show him that it is because there was more grading to be done on his street, or more curb to be set, and that the paving itself does not cost him a cent more. The probability is, however, that the facts will appear so plainly in the published figures that we will not need to explain at all.

In the previous remarks, paving has been used for illustration, but the same ideas apply to sewer construction or any other kind of public work. It is only when costs are itemized that cost records of such work will be of value for making future estimates, or making comparisons with costs of previous years or of other cities.

Such itemizing is essential for obtaining efficiency and economy. How can we expect to cut down costs if we do not know what items are high ones? Can a manufacturer know how to increase his profits if his accounts show, not what individual items cost him to produce and market, but only his total profit or loss for a year?

Standard Units

If the only aim is to compare costs in your own city and on work done by you individually, then each man might select his own units for measuring and expressing quantities of work. But how much more valuable his cost records would be if he could compare them with those of all other cities and of previous administrations in his own city!

This means that he and all others should use the same units. That when he says "a square yard of asphalt pavement" he means exactly the same thing as every other man who uses the term.

A very considerable number of cities do keep their records and receive their bids itemized as described, but they find the undoubted value of this is lessened by the fact that not all use the same units for measuring the work done, or use them with exactly the same meaning.

To remedy this condition, the American Society of Municipal Improvements has, after two or three years' consideration, adopted a few of the more important units for paving and sewerage, which it recommends as standards for universal use. This society numbers among its members most of the leading city engineers and consulting engineers on municipal work, and it is to be presumed that the units which it adopts will be those best adapted to the purpose which seems practicable at this time. The standard paving specifications which the society has prepared are now generally accepted as the standards for the country, and it hopes that its standard units also will be generally adopted. When each standard kind of pavement is laid by everyone according to a standard method and measured with a standard unit, we will then be able to make comparisons which will have a real value—which we are not able to do now.

The standard units for street paving and sewer construction referred to are given below:

A. S. M. I. Standard Units for Street Paving

If these units are used, a statement to that effect in a report or description, without further explanation, gives certainty of meaning to the figures.

PAVEMENT: The wearing surface down to the base, if any. Includes cushion or binder course, but not concrete, macadam, or other base. If base is included, describe as "pavement and .... inch (concrete or macadam) base." In the case of macadam or concrete pavement, the term includes all down to the earth foundation. Unit, the equare yard, giving material and thickness. Ex.: 1524 sq. yds. of 3 in. asphalt pavement.

BASE: The concrete, macadam or other material placed under the pavement to distribute the load on the subgrade. Unit, the square yard, naming thickness and material. Ex.: 1524 sq. yds. of 6 in. concrete base.

EXCAVATION; EMBANKMENT: All material removed before laying base, curb or sidewalk; or all material added, up to base, curb or sidewalk. Unit, the cubic yard, naming material. Ex.: 600 cu. yds. of earth excavation.

CURB: Complete construction of new curb, except excavation or embankment. RESETTING CURB: Same, except furnishing of curb stone. Unit, lineal foot, naming (in inches) depth and mean width of curb, and material. Ex.: 952 ft. of 7 x 18 granite curb reset; 750 ft. of 6 x 16 concrete curb.

GUTTER: Same as curb. Unit, square foot, stating thickness and material. Ex.: 1428 sq. ft. of 6 in. concrete gutter.

SIDEWALK: The artificial wearing surface, not including excavation or embankment, nor base of cinders or other material, if any. Unit, the square foot (or square yard, if preferred) giving average thickness and material. Ex.: 1720 sq. ft. of 6 in. concrete sidewalk.

SIDEWALK BASE: Cinders or other material placed under sidewalk. Unit, the cubic yard, naming material. Ex.: 122 cu. yds. of gravel sidewalk base.

A. S. M. I. Standard Units for Sewer Construction

If these units are used, a statement to that effect in a report or description, without further explanation, gives certainty of meaning to the figures.

CONSTRUCTING SEWER: Excavating trench (except rock and street pavement), furnishing material for and constructing or laying the sewer barrel (not including branches, manholes or other appurtenances, special foundations, etc.) and backfilling (not including relaying pavement). Excavation of rock, sheathing left in trench, and removal and replacing of pavement paid for extra. Depth of excavation is measured from street surface to invert of sewer, and classified by two-foot intervals. Unit, the lineal foot (measured along the entire length of the sewer, including manholes and specials), naming size of bore and material of sewer, and depth. Ex.: 10 in. vitrified sewer, 950 ft. 8 to 10 ft. deep; 630 ft. 10 to 12 ft. deep.

BRANCHES: Y or T branches inserted in the sewer; the price paid to be additional to that paid for the sewer in which the branch is inserted.

MANHOLES: The total structure, including bottom and top casing, steps, etc., additional excavation and backfilling. Standard be taken as 6 feet deep; and depths exceeding this to be given in additional feet depth. Price is in addition to that paid for sewer (measurement for which includes manholes, as stated above). Unit, manhole of standard depth, giving bottom diameters in feet; and feet of additional depth. Ex.: 7 manholes 3 x 4½, and 22 ft. additional depth. (This means that the sum of the depths was 64 ft., and the average depth was 9 1/7 ft.).

REPLACING PAVEMENT: Grading top of trench back-fill, putting in pavement foundation (if any), and laying wearing surface (replacing any material damaged in removing same.) Unit, square yard, naming kind of pavement. Ex.: removing and replacing 726 sq. yds. of brick pavement.

Highway Improvements in Nova Scotia

A Number of the Larger Bridges Illustrated—Steel Construction Favored Above 35 Ft. Span

IN our last issue we illustrated a number of the smaller bridges of Nova Scotia—culverts for the most part—which are such an important part of the highways of any country. The cuts reproduced herewith illustrate some of the larger bridges of the province. In the report just issued, it is stated that concrete construction has been used during 1915 in larger bridges much more extensively than in any previous year and that the majority of the larger bridges built during the year were of reinforced concrete.

Varner Bridge, New Germany, Lunenburg Co.—140 ft. steel span on concrete abutments.

Steel Bridges

The number of steel spans built this past fiscal year is very small,—only four. The number and size of the various steel spans which were awarded during the year were as follows:—

Fixed spans	1— 45	feet end pin centres.
	1— 60	feet end pin centres.
	1—100	feet end pin centres.
	2—150	feet end pin centres.
	3—200	feet end pin centres.
Draw span	1—205	feet end centres.

For all the steel spans erected during 1915 the new specifications covering the construction of steel bridges prepared last year have been used. The report states that the steel bridges present a very substantial appearance and the anticipations regarding them will be realized in that their lasting qualities are increased far beyond the proportionate extra cost. In particular the floor design is much more substantial than formerly, and the matter of upkeep of the wooden floors, which will be used for some years at least, will be very materially

Hetterick Brook Bridge, Bear River, Annapolis Co.—20 ft. concrete arch on stone abutments.

Concrete Bridge Design

In last year's report it was intimated that the designs of reinforced concrete structures had been completed up to spans of 30 feet. During the year 1915 further standard designs were prepared covering reinforced concrete spans of 35, 40, 45 and 50 feet. While the four designs mentioned make very strong structures and are particularly pleasing as regards appearance, yet they have not so far been applied in any instance, as it has been found that the cost of concrete structures of such spans exceeds that of our lightest class of steel bridge designs, together with concrete floor.

The four designs alluded to, however, should be found particularly adapted to situations near the larger towns in the province in places where the amount of travel warrants a little more expenditure to secure the most lasting structure possible, or in situations where a more massive structure than framed steel trusses would be desirable for the sake of appearance.

In the construction of larger bridges during the year, the practice of the Roads Department has been to build the con-

Musquodoboit Harbor Bridge, Halifax Co.—75 ft. steel span on dry stone abutments. This was the first steel bridge erected in the Province of Nova Scotia.

Conquerall Bridge, over Petite Riviere, Lunenburg Co.—Three spans, 16 feet each, concrete slab.

Wild Cat Bridge on Molaga Road, Queens Co.—Four spans, 16 feet each, concrete slab.

Walsh Bridge, Erinville, Guysboro Co.—Two spans, 20 feet each, concrete beam and slab.

Burrs Brook Bridge, Bellecote, Inverness Co. 23 ft. span, concrete beam and slab.

crete substructure of steel bridges as far as possible by day labor and the steel superstructure by contract. All reinforced concrete bridges have been built by day work. The Roads Department was influenced in this matter by the fact that reinforced concrete work is somewhat new in the province and it was thought advisable to defer the letting of contracts for this kind of work until a little larger experience had been gained.

The largest bridge upon which work was begun during the year 1915 was the Lennox Passage bridge, which consists of six steel spans with concrete floors; two fixed, of 150 feet each; three fixed, of 200 feet each; and one swing, 205 feet. Owing to war conditions and the uncertainty of delivery of material, the contractors experienced considerable delay in the construction work, especially with the piers and abutments. Other large bridges upon which construction was undertaken were: the Eel Lake bridge, which consisted of a concrete beam bridge of 25 feet span, and an earth fill about 1,500 feet long; the Carrigan Mill bridge, a steel span bridge of 45 feet, end pin centres; the Eben Fulton bridge, 100 feet steel span with a 15-foot roadway; the Navy Pool bridge, steel span of 60 feet; Taylor bridge, 6 feet span, 37 feet long, with an earth fill of about 900 cubic yards.

For the steel bridges, the contracts of two of them were awarded to the Maritime Bridge Company, Limited, New Glasgow, and the remaining two to Robert Musgrave, North Sydney.

The following is a statement of the moneys expended on the construction of larger bridges during the fiscal year 1915:

The total amount expended on larger bridges during the fiscal year 1915 was $81,945.46.

The expenditure on the construction of larger bridges since the passing of the Bridge Act in 1883, is as follows:

Expenditure to Sept. 30, 1914	$3,288,268.82
Expenditure fiscal year 1914-15 ...	81,945.46
Total	$3,370,214.28

Marking Roads with Simple Signs

A U. S. county has adopted the policy of marking its highways with signs indicating the direction and distance to all towns within its limits.

The signs are made of iron. The main plate, on which the letters are riveted separately, is about No. 14 gauge. The letters are of the same thickness and are painted aluminum, the plate being black.

In ordering the signs a sketch is made to show in which direction the signs would point. After the arrival of the signs, two men with a posthole digger, bar, shovels, etc., are sent out in a Ford car. This crew goes ahead and has the hole dug. A slower auto truck follows, carrying the signs, sections of 2-in. galvanized water pipe 12 ft. long, cement, sand gravel, and a couple of buckets. As soon as the truck arrives the signs are clamped to the pipe in he direction in which they are to point. At the same time one of the men mixes a grout of sand, cement and water to a very thin consistency. As soon as this is ready the pipe is placed in the hole, which is dug about 3 feet deep, leaving the signs about 9 feet in the air. Then grout is poured in to the hole and rocks added; the filling is thoroughly tamped with an iron rod. As the level of the mixture nears the ground surface the grout is thickened with sand, and the last foot is mixed the same as concrete.

The cost of the sign complete, with about 20 letters, is $5.50, of which $3 is for the pipe alone.

Noel Village Bridge, Hants Co. 24 ft. span, concrete beam and slab.

Stone from Crookston Quarries

The Province of Ontario has long been noted for its limestone productions of various kinds, adaptable to building and constructional purposes, and many large formations are to be found in different parts. In Hastings County possibly the largest and most important formation of this nature now in operation is known as the "Crookston Quarries," owned by Quinlan & Robertson, Limited, of Montreal, who also control other quarries in different parts of the country. Crookston is located on the Grand Trunk Railway from Belleville to Madoc, and also has the main line of the Canadian Pacific Railway running through it.

The quarries operated by the company at this point have been open for over 50 years, and although thousands of tons of stone have been taken out, the formation of the beds is such that it will admit of dimension stone of the largest size being quarried. The coloring of the product, which is a bluish grey limestone, particularly lends itself to building construction, and does not darken or stain to any appreciable extent with weather conditions. Many buildings throughout the country represent Crookston stone, examples of which are Belleville Roman Catholic School and Church; Roman Catholic Manse, Tweed; Belleville Armouries; Toronto Armouries. Crookston stone was also used in the construction of the Victoria Bridge at Montreal, and in the majority of bridges in both the C. P. R. and G. T. R. from Montreal to Toronto this stone will be found. A strong example of the durability and tensile strength of Crookston stone is found in the wheel pit of one of the power houses at Niagara Falls, where it was chosen in competition and test over several other well-known quarries. The following list will indicate the general uses for which this stone has been found suitable.

Soulanges Canal, one lock and coping for bridges; lock at Black's bridge, Montreal, Lachine canal; all bridges on double track C. P. R. from Merrickville to Vaudreuil; a number of bridges on G. T. R. outside Montreal and from Montreal to Toronto; Bothwell bridge, Ontario; Belleville armories, and the drill hall are trimmed with Crookston stone; Victoria bridge, Montreal; wheel pit of power house, Niagara Falls; Catholic Church, Belleville; St. Michael's Academy, Belleville; some of stone in armories, Toronto; Catholic Manse, Tweed; A. W. Robertson's house, Montreal; bridge at Lake Pierre St. Paul on G. T. P.; many of G. T. R. stations.

An up-to-date crushing plant is also operated at the quarries with a capacity of 500 tons of crushed and rubble stone a day. The Crookston crushed stone is a clean, tough stone, specially suitable for concrete mix and all classes of road construction. It is being sup-

St. Michael's Academy, Belleville—Crookston Stone.

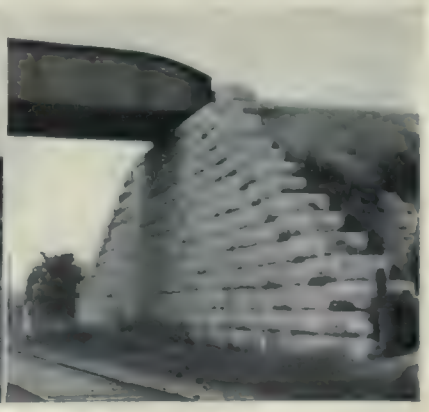
plied at present for the construction of the Bloor Street Viaduct in Toronto. The company claim that although they have shipped hundreds of tons of this stone they have never had one car rejected, and with both C. P. R. and G. T. R. shipping connections they are prepared to fill all orders promptly. The resident manager of the firm, Mr. W. E. Tummon, has had years of experience in quarrying operations.

Magnesite Deposits in British Columbia

Magnesite, one of the most valuable of the non-metallic minerals, is used in the manufacture of bricks for refractory furnace linings, non-conductive coverings for steam pipes, boilers, etc. The salts of magnesium also find use in the arts and in medicines, and in the pulp and paper industry. The world's supply of this mineral has so far come from California, Greece and Austria. The war has cut off the last-named source, causing an extraordinary demand for the material. Recently, large and valuable deposits have been discovered in the north-eastern part of British Columbia, and this province will soon be in a position to supply. This will be of great value to British Columbia, since the spruce forests have large paper-making possibilities, and with magnesite, necessary for a finished product, right at hand, the importance of the pulp industry will be greatly increased.

Crookston Quarries.

The Big Crushing Plant.



Used Largely for Railway Bridges.

Mainly Constructional

East and West—From Coast to Coast

The plans for a new high school in Beamsville, Ont., at an estimated cost of $25,500, have been adopted.

A recent fire at St. Evariste, Beauce, Que., resulted in the destruction of 18 houses with a loss valued at $75,000.

The council of Brampton, Ont., have accepted a tender of $22,955.40, for the erection of a new school in that town.

A $2,000 steel bridge is to be erected over Old Man Creek near Burks Falls, Ont., to replace a wooden structure now in use.

It is understood that a movement has been commenced by the ratepayers of Gray Street in Chatham, Ont., to induce the city to pave that street.

Building permits amounting to $600,000 were issued in Winnipeg during the month of June, the largest being for the Bank of Hamilton, $400,000.

The Ottawa Board of Control have decided to pave Hamilton Avenue and Daily Avenue. The width of the paved roadway proposed is 20 feet.

The board of education of London, Ont., have approved and signed the contracts for the new technical and art school to be erected on Dundas Street East.

The city council of Port Coquitlam, B. C., have decided to grade and improve Dominion Avenue, from the Dewdney Trunk road to the Pitt River shingle mill.

The Storey Pump & Equipment Company have recently installed two Morris turbine pumps, capacity 1,500,000 gallons each, for water supply at Camp Borden.

Two Morris turbine pumps, capacity one million gallons each, for water supply at Niagara-on-the-Lake, have been installed by the Storey Pump & Equipment Company.

It is probable that a creamery will shortly be erected at Agassiz, B. C., as the incorporation of the Agassiz Creamery Company, under the Agricultural Act of 1915, is announced.

City Engineer Fairchild, of Galt, Ont., recently stated that building permits issued to date for 1916 totalled $100,100. This year promises to make a record in the building trade for Galt.

Forty-one building permits were issued in Vancouver for the month of June, representing a value of $42,720. The total number of permits for the first six months of the year is 204, amounting to $434,050.

The Canadian Products Limited, recently commenced the construction of a $30,000 vegetable evaporating plant at New Westminster, B. C., on the water-front. It is hoped to have the plant in operation within a few weeks.

Two hundred and seven building permits were issued during the month of June in the city of Montreal, representing a value of $748,050. The total for the first six months of the year is 950, representing a value of $2,434,344.

The contract for the construction of the government long distance telephone line from Prince Albert, Sask., to Shellbrook, a distance of about thirty miles, has been awarded to the North Saskatchewan Telephone Construction and Development Company, of Prince Albert.

It is understood that arrangements have been made for the construction of a two-storey block at the corner of Arthur and Cumberland Streets in Port Arthur, Ont. The building, which is to be leased by the Woolworth Company of New York, operators of five, ten and fifteen cent stores, will be entirely modern in construction, and will have entrances on Arthur and Cumberland streets.

The south span of the railroad and traffic bridge over the Kicking Horse River near Golden, B. C., was recently carried away by heavy floods. Damage was also done to other bridges along the river. Traffic has been tied up to some extent as a result.

Building permits issued in Chatham, Ont., for the month of June this year totalled $87,800, as compared with $4,865 for June, 1915. The permits for the first six months this year amount to $156,170, while for the same period last year the figures only reached $82,000.

The building permits issued at Welland, Ont., during the month of June this year represent a total of $13,185, as compared with $10,124 in June, 1915. The total for the first six months of the year is $112,381, while for the corresponding period last year it amounted to $90,997.

The city council of Port Coquitlam, B. C., have awarded the contract for gravelling, grading and ditching a considerable portion of Mary Hill Road to Mr. J. B. Wilson, at a cost of $1,700. This contract price is to apply on arrears of taxes on Mr. Wilson's property in that district.

The British Columbia Electric Railway Company are replacing their old freight shed on Front Street, New Westminister, B. C., with a new structure of somewhat altered design, which will be placed in line with other buildings on the improved water front, at a cost of about $2,000.

The cornerstone of the new parliament buildings will be laid by His Royal Highness the Duke of Connaught before he leaves for home in October. The cornerstone of the old structure, which was laid by the late Edward VII., when Prince of Wales, will be the cornerstone of the new building.

Mr. Thomas Adams, the town-planning engineer of the Dominion Conservation Commission, recently paid a visit to Port Arthur, Ont. He was enthusiastic over the natural advantages of Port Arthur and expressed the opinion that the city had been far-sighted in making ample provision for parks and playgrounds.

It is probable that repairs will be undertaken to the Coal Harbor causeway in Vancouver, B. C. City Engineer Fellowes reported that the piling had been examined and that some of the original piles were in bad condition, but that no evidence could be found of teredo having attacked the new piling to any extent.

A large deputation of good roads enthusiasts recently interviewed Premier Norris, and they have received assurance from him that the Manitoba Government will complete the Jefferson highway from Emerson to Winnipeg and that the Manitoba portion of the road would be as good as that south of the international boundary.

A recent heavy rain storm in Fredericton, N. B., demonstrated that a number of the surface sewers in the city were not capable of handling an unusual rush of water such as was then caused. City Engineer George McKnight stated that he had discovered several sewers to be practically useless and some of them will have to be rebuilt.

Despite the very emphatic protests sent to the G. N. R. officials by the mayor and council of the city of Vancouver, the company still announce that it is their intention to use terra cotta trimmings on the new depot being erected on False Creek. The plans, however, have been somewhat altered to require a smaller amount of these trimmings.

The Hydro-Electric Commission have notified the Board of Works of Peterboro, Ont., that they are prepared to extend the Charlotte Street car line south to Paterson Street, as soon as the roadway is placed in good condition. Engi-

neer Parsons reported that he had arranged with North Monaghan to repair the boundary road, Charlotte to Sherbrooke, Weller to Smith, and Chamberlain to C. P. R. tracks.

Mr. F. A. Lightfoot, contractor for the St. Charles and Huron River Railway extension in the province of Quebec, reports that conditions around Stoneham are favorable. He has a gang of men putting in 1½ miles of new track, and with other projections expects the work to last well into the fall.

Weather conditions this spring have greatly interfered with the completion of the Toronto-Hamilton highway. Four machines are at work, however, and four miles of new concrete have already been laid—at Lorne Park, Port Credit, Oakwood, and Burlington. The commission expect to complete the system before August 31.

At a recent meeting of the Committee on Public Monuments of the city of Montreal, a resolution was passed asking the Board of Control and City Council to name a board of competent advisers to pass upon designs of new buildings from the artistic point of view, the board to have power to decide on the building line, height and material of buildings.

Excavation work has begun on the construction of a reinforced concrete factory building, 65 x 100 feet in dimension and four storeys high, on the southwest corner of Bloor and Dufferin Streets, Toronto, for the T. Eaton Company, Limited. This building will probably cost about $50,000. Adjacent to it there will also be a one-storey factory, 63 ft. x 130 ft.

The Chilliwack Evaporating and Packing Company, Limited, has been incorporated with a capital of $10,000. The new company have taken over the plant and property of the Chilliwack Canning and Preserving Company, and will convert it into a large evaporating plant. The contract for the work has been let and will be rushed to completion as early as possible.

Norman McLeod, Limited, of Toronto, has entered action against the Orillia Water, Light & Power Commission to recover $16,595.71 for material supplied and work performed under a $20,000 contract dated October 27, 1914. The cost of building and pumping station and tanks is alleged to have been increased by the discovery of quicksand and by changes in design.

A deputation from the Builders' Society and the Plasterers' Union recently made a request to the Property Committee of the Toronto Board of Education that in future a clause be inserted in all building contracts providing for the exact wages to be received by each workman per hour. The request is to be put in writing and considered at the next meeting of the committee.

The city council of St. John, N. B., have approved the calling of tenders for paving North and South Market streets. It is planned to lay 7-inch concrete pavement over road foundation. The two streets would require 2,275 square yards of pavement, 650 feet of new curb with the 960 feet of old curb. Water extensions, at an estimated cost of $1,500, have also been approved.

It is announced that the architects on the new parliament buildings, J. C. Marchand, of Montreal, and J. A. Pearson, of Toronto, who will supervise the architectural work under construction, will receive 5½ per cent. on the cost to five millions and nothing on cost beyond that figure. The time for completion of the buildings has been extended from October, 1917, to December 31, 1918.

The Grain Growers' Company, of Winnipeg, have awarded the contract for their proposed grain elevator to be constructed on the waterfront at Port Arthur, Ont., to S. J. McQueen, of Fort William. This structure is to be erected near the site of the Saskatchewan Elevator Company's proposed building. It will be modern, including workhouse, and is to be ready to receive this year's grain.

The building trade in Renfrew, Ont., is booming. Between 25 and 30 new residences are being erected in the Plaunt subdivision of the town, recently opened up, and the town council has been asked to lay a water main. It is expected that throughout the town fully a hundred homes will be built during the present year. At present the demand for houses greatly exceeds the supply.

The good roads movement in Essex County is to be pushed along as quickly as possible. W. H. Huber, C. E., engineer for the Ontario Highways Department, visited Sandwich recently for the purpose of meeting the Special Good Roads Committee of the Essex County Council and going over the roads laid out in the county scheme, and to estimate the cost and give the committee the details necessary for the by-law.

A deputation recently interviewed the Hon. Robert Rogers, Minister of Public Works, Ottawa, concerning proposed harbor improvements at Port Dover, for the commencement of which an appropriation of $50,000 was recently placed in the estimates. Plans requiring $250,000 were made some time ago, but within the last few weeks soundings have been taken with a view, possibly, to alterations or temporary work on a smaller scale.

At their recent session the council of Simcoe County, Ont., passed a resolution that no grants be made this season unless the local municipality within which the grant is used will supplement the same with an amount and expend the money in a manner such as will earn a provincial supplementary grant equal to that made by the county. The grants recommended on county roads, bridges, etc., to the various municipalities and villages amounted to $4,055.

A building permit for the construction of a warehouse and workshop in Victoria, B. C., on the Dominion property across the Johnson Street bridge has been issued to the Department of Marine and Fisheries, at a cost of $16,300, being part of the work arranged to be done in connection with the storage of aids to navigation at the Dominion wharf. Parfitt Brothers, Limited, the contractors, have already done a considerable amount of the preliminary work.

Liquid chlorine instead of raw hypochloride of lime is to be used in the water supply for the city of Ottawa very soon. The city waterworks committee is recommending to council that a temporary plant for the injection of liquid chlorine be erected at once, at an estimated cost of $960. This change is made necessary, according to Waterworks Engineer Haycock, because the blasting work being done by Messrs. Doran and Devlin on the construction of the overland pipe system is breaking up the hypo tanks.

James A. McIlwee & Sons, of Denver, were recently awarded a judgment of $376,000 against Foley, Welch & Stewart, contractors for the Rogers Pass Tunnel on the line of the C. P. R. The Denver concern, several years ago, was employed as sub-contractor on the tunnel, which is now almost finished, at a cost of upwards of $10,000,000. A disagreement arose, and the McIlwees were put off the work. In consequence they brought an action claiming prospective profits in boring operations, and the case has been decided in their favor.

A resolution has been passed regarding the securing of an agreement between the city of Port Arthur, Ont., and the C. N. R. to run a spur track along Court Street, from Ichiquin to Cornwall Avenue, and it is now stated that H. Bray & Company intend erecting an elevator and feed mill combined, if these tracks are secured. This plant will contain all modern equipment and will be prepared for the handling and cleaning of all grains. It is the wish of the

promoters to have the elevator ready by October 1 to handle the moving crop then.

The municipal council and residents contiguous to the North Road in Coquitlam and Burnaby, B. C., appeared before the Board of Railway Commissioners in Vancouver to oppose the application of the V. V. & E. Railway for an order to replace the 66-foot macadam roadway, where it crosses the railway, with a 24-foot trestle bridge. The council contends that the railway company should either be compelled to carry out an original order to construct a steel and concrete bridge or to construct a tunnel to carry the railway under the North Road.

Architects' plans have been obtained for remodelling the front of the building at 553 Granville Street, Vancouver, known as the Leigh-Spencer building, and a decision made to change the name of the block to "Central Building." The building has passed from the ownership of Miss Leigh Spencer to the Victoria firm of Elliott, Shandley and McLean. Mr. L. A. Rostein, of Vancouver, has been named building manager; he states that the interior of the block will be somewhat changed, as well as the front and entrance, and that the plans include the substitution of a new elevator service.

The city council of Victoria, B. C., recently issued a special permit to the Cameron-Genoa Shipbuilders, Limited, for the construction of three buildings on the Songhees Reserve, which do not comply with the by-law. Provision for non-inflammable sheathing of the buildings will be made, together with hydrant and other fire protection services. The Cameron-Genoa concern have decided to build three ships, which will be of the five-masted, baldheaded-rig type, and the services of J. H. Price, manager of the St. Helens Shipbuilding Company, of St. Helens, Ore., have been secured for the supervision of operations.

At their June sessions the council of Lanark County, Ont., decided to spend $100,000 on extending the good roads system of the county. Thus on the percentage basis of co-operation, this will mean a grant of $60,000 from the Government. The good roads proposition was discussed from all angles, and several new machines, including a steam roller will be purchased. The road commissioner is to receive instructions to examine the bridge over the Mississippi on the Lanark and Perth road, and if it is in unsafe condition he will receive authority to make the necessary repairs or to reconstruct the bridge at a cost not exceeding $8,500.

A company, of which George Oakley, of Toronto, and E. C. Giberson, of New York, are the promoters, have made arrangements for the erection and operation of a stone cutting plant at Point Edward, Ont. The contract for the foundation has been awarded to Messrs. Gutteridge & Grace, of Sarnia, and it is understood that work is already under way. The building will be constructed of cement and will be 107 feet x 180 feet in dimensions. A railroad track will run down the middle of the factory so that heavy stone and material can be conveniently handled. The latest type of stone cutting machinery will be installed. Eventually it is expected the factory will give employment to 100 men.

As the first step towards a scheme for the creating of terminal facilities for Vancouver harbor, the harbor commission has submitted an application for the approval of an issue of $5,000,000 of bonds to enable the commissioners to acquire and develop certain property, including the Kitsilano Reserve, the estimated cost of which is $700,000, an area of 88 acres at Port Moody, the Heaps property on Burrard Inlet, wharf property and warehouses of the Great Northern Railway, and waterfront property east of the Great Northern Railway, together with appropriations for a right-of-way for a harbor terminal railway and a portion of the present right-of-way of the P. G. E. Ry. The application has received the approval of the committee of the Privy Council.

Two frame buildings for temporary university accommodation are to be built by contract, for the University of British Columbia. The new buildings will be erected on the general hospital land at Tenth Avenue and Willow Street. The largest of them will be an assembly hall of one storey, 125 x 100 feet, and will contain a large auditorium and four classrooms. The second building will be for the accommodation of the chemistry and physics classes. It will be 53 by 153 feet and will contain several classrooms fitted with the necessary apparatus. Alterations are also to be made to the old building now used by the applied science students and faculty, and to the Arts building. An addition, 31 x 41 feet, will be made to the present mining building. The whole of the work, new buildings and alterations, is expected to cost about $40,000.

Assessment Commissioner Forman and Works Commissioner Harris, of Toronto, have reported to the Committee of Works that it will cost $106,739 to extend Crawford street south of College street, including the filling in of Sully street and the abandonment of Shaw street bridge. They recommend the purchase of all the properties on Sully street which are now privately owned, 37 in all, and then extend Crawford street to connect with College street. It is proposed to fill in the ravine from the rear of the lots fronting on the west side of Shaw street easterly to Montrose avenue, the sum of $17,572 to be levied against the properties benefited. The cost would be made up as follows: Land, $84,678; engineering, $16,000; interest and commutation of local improvement rates, etc., $10,000; total, $161,031, from which a deduction of $54,292 for the value of the land available for building would be made, giving a net cost of $106,739.

Thomas Allison, county road superintendent of Wentworth, Ont., is quoted in the Hamilton Spectator as follows:

"We have about one hundred and fifty miles of roadways in Wentworth County, but one has to drive five hundred miles to cover them. I have just completed an inspection of all county roads, and while many of them are not in the condition I would like to see them in, I think I am safe in saying that they are the best county roads in Canada today. We have not a single foot of concrete roadway in Wentworth County, but the time has come when we will have to construct concrete roadways instead of macadam. Macadam roadways are alright for light traffic, but in these days of automobiles they are the most expensive kind to construct, because of the additional cost of maintenance. The Hamilton and Dundas roadway to Blinkley Hill, and the Caledonia road should be concreted, and reconstructed on a forty-foot basis, thirty feet of concrete and ten feet of macadam shoulders. This work should be done not later than next year; in fact, all roadways requiring renewing should be concreted next year. The initial expenditure would be considerable, but cheaper in the long run because of the lesser cost of maintenance and complete elimination of possible damage actions incident to rough roadways."

Personal

Mr. W. K. Jeffrey, formerly general manager of the Ottawa Car Manufacturing Company, Limited, has been appointed sales manager of the Lyman Tube and Supply Company, Limited, 323 St. James Street, Montreal. The company recently purchased the railway and supply department of John Millen & Son, Limited, and are agents for a number of leading United States, English and French firms.

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The New Welland Ship Canal

THE Contract Record devotes a large part of this issue to a description of one of Canada's greatest engineering projects—the Welland Canal.

Anyone, engineer or layman, who has seen the work in progress, who has witnessed the difficulties overcome and the ingenuity displayed, cannot be other than enthusiastic over the almost superhuman skill displayed in its conception and construction.

The work is progressing more slowly than was hoped when operations were commenced in 1913, but this could not be otherwise under existing world conditions, and it speaks well for the resourcefulness and stability of our country that, in the face of a war calculated by our enemies to entirely exterminate us, we carry along our preconceived plans with undisturbed and imperturbed confidence. This is all the more remarkable since the Welland Canal is not a commercial proposition; it is at the service—without money and without price—of all ships that navigate the great lakes, of whatever nationality.

And this naturally raises one of the biggest problems in the engineering and commercial field to-day—what is the value of water routes. Since the beginning of time there have been advocates of the necessity of this means of transportation and such great works as the Welland Canal, though not commercial propositions in the usual sense, have very strong advocates. Canals have so many inherent weak points, however, that it is an easy matter to argue against them. Take the Panama Canal as an example, rated as the greatest engineering accomplishment of the age, and yet the people of the United States have had very little satisfaction out of their half-billion dollar expenditure. One single weak point has rendered the whole canal useless for many months. To further offset this we have very rapid developments in overland transportation.

However, the unexpected often happens, and it is for this that many a great national work has been carried through. Germany, for example, never could have foreseen the value of the Kiel Canal in protecting her fleet from destruction through all these twenty-four long months. Who knows but that those who have advocated the Welland Canal as a national necessity may some day be equally justified? In the meantime it is a fine example of modern engineering skill and of the progress human beings are making in overcoming the forces of nature. For this work Chief Engineer Weller appears to be especially fitted, to whom and his splendid staff and organization, plainly evident even under present adverse conditions, Canada may look with confidence for the successful completion of this work.

Should Citizens Decide Technical Questions?

THERE has been too much of a tendency to allow municipal improvements to be selected by citizens. Not that they should not have an interest in the improvements they are to use, but the average property holder is technically unqualified to judge of the merits of any particular type. Too often the selection of such municipal improvements, as a filtration plant or sewage disposal works, is left for the citizens to decide upon by vote. A citizen most certainly has the right to say what he wants, but for large engineering jobs he has not the requisite technical knowledge that will enable him to judiciously select the types or fairly compare the merits of alternative types. The result is that the choice is based on prejudice, politics, or influence.

The reason for allowing this extent of freedom seems to be that people have a right to say what they shall pay for. They foot the bill and they must choose what they buy. This is reasonable, of course, as far as normal purchases are concerned. A man will not buy a suit of clothes by specifications as a Government purchases army uniforms. But for the things that call for a higher degree of technical knowledge than he possesses, he should allow those who are qualified to do the specifying. This applies with considerable force to the selection of street pavements, for example. The local improvement system of assessment seems to ascribe to citizens the right to select the type of pavement to be laid in front of their property. The result

is that, not knowing the comparative merits of different types, the influence of a paving company in many cases governs the choice. In making comment on this particular subject, the "Engineering Record" says:—

"The average citizen pays no attention to the condition of the streets, though possibly the advent of the automobile requires that this statement be qualified. Even when he does notice them, he is not sufficiently familiar with traffic conditions and construction details to know why one pavement proves a success and another a failure. One might contend that the average citizen may be qualified to pass some sort of judgment on the type in use on his own street for a term of years. But even were this granted, there would still be inability to judge of the merits of alternative types.

"Were the citizen left to himself, to judge by his experience and by the data placed at his disposal by a competent city engineering department, the results might not be so bad. Unfortunately, from the time a new pavement is proposed to the date of signing contracts, he becomes the object of attack of the material salesman. Intent only on getting their products used, these men urge the use of their materials, whether or not they are adapted to the particular conditions. Even an engineer has need for great steadiness to resist this selling assault. What hope, then, is there that the layman will pass a reliable judgment? The result is obvious. The salesman with the glibbest tongue, or the one who can win a group of influential citizens, will get his material used. The real merits of the case do not receive consideration. The pavement is bought on price—first cost—not on quality. Total cost is entirely lost sight of.

"Fortunately, some citizens are abandoning this objectionable method of pavement selection. One improvement, and a great one, consists in putting in the hands of the city engineer the power to designate two or three types, from which a selection must be made. Even this, however, is a makeshift. Granted that for given traffic and other conditions, two or three types are equally satisfactory—which is obviously not true—the engineer would nevertheless be in a better position to make a selection than the layman."

The article further advocates that the best method of procedure is to have the city engineer designate the type that must be used, since his choice would be based on all the factors that should be considered—foundation conditions, traffic, ability of the district to stand the assessment, characteristics, cost and life of various surfacings. This should not be deemed an unwarranted inroad upon the right of the citizens to indicate for what their money should be spent.

Manifestly the wishes and views of citizens should be considered, but they should be but one of the factors. Abandonment of the present system seems necessary before city paving and other public improvement work in this country will be on a satisfactory basis.

Wear Tests of Concrete

At the recent annual meeting of the American Society for Testing Materials, Professor D. A. Abrams, of the Lewis Institute, Chicago, delivered a paper describing practical methods for testing the wearing qualities of concrete as used on the wearing surface of roads. The method of procedure is to make a large number of test pieces using the proportions of Portland cement and aggregate as is proposed for use in the road material. For comparative purposes several different mixtures may be made up and available aggregate materials in the vicinity of the road to be built can be represented by test pieces in various combinations so as to compare the wear of the various aggregates before using.

For test pieces, Prof. Abrams uses concrete blocks eight inches square and five inches thick. As the blocks weigh approximately thirty pounds each the test is severe enough to represent very well the wear of road surface service.

The Talbot-Jones rattler used for this test consists of forming a drum of the test pieces using wooden wedges between each pair of pieces to give an approximate circle. When so "set up" the drum is firmly clamped together by means of steel bands fastened with drawhead bolts. Ten specimens of concrete are used in this way at one time. Two hundred pounds of cast iron spheres are placed inside the drum, which is closed by means of clamping devices, and the drum made to spin so that the cast iron balls strike, rub, roll and grind together against the inside surface of the blocks forming the drum.

Prof. Abrams claims for the method so developed the following advantages:

1. The concrete is subjected to a treatment which approximates that of service.

2. The test piece is of usual form and of sufficient size that representative concrete can be obtained.

3. The test pieces are convenient to make, store and handle, and require a relatively small amount of concrete.

4. The cost of tests is not excessive.

5. The machine used is found in numerous testing laboratories.

6. The wearing action takes place on the top or finished surface of the concrete. This makes it possible to study the effect of various surface treatments or finishes.

7. Several tests may be made at the same time, thus enabling more representative results to be obtained.

8. Tests may be made on sections of concrete cut from roads which have been in service.

9. Other paving materials, such as brick, granite blocks, etc., may be tested in the same way as the concrete.

Production of Portland Cement

A bulletin on the Portland cement industry issued by the U. S. Geological Survey, says:—

In 1914 and 1915 there was a decrease in the production of cement, consumers exercising strict economy in its use, but the year 1916 shows a reaction, having opened with a demand unprecedented for a midwinter season. Prices, which had averaged only 86 cents a barrel for the entire year 1915, began to rise toward the end of the year, and in the Eastern and Middle States, where cement sold at 70 to 90 cents a barrel they continued to rise in 1916 until, in June, they ranged from $1.10 to $1.25 a barrel. The increased prices, of course, do not mean an equivalent net increase in returns to the manufacturers, for the costs of explosives for blasting and of coal, have both risen, and laborers are in many places demanding an increase in wages. These comparatively high prices have not, however, checked the demand for cement. Many manufacturers are selling all they can produce, and others are even drawing on stocks so as to fill orders promptly.

The Determination of the Justifiable Cost in Highway Construction*

The selection of the best and most economical type of road to build in any particular case involves the consideration of a number of conditions affecting such a determination.

The term economical is here used in its broadest sense and is not to be interpreted as meaning cheap or low in first cost. The road of low first cost very often proves to be the most expensive in the long run because important principles were sacrificed in the original construction for reasons of so-called economy.

"The greatest enemy of good road construction is the desire to get something at a price inadequate to meet the conditions imposed. Any expenditure is justifiable which is necessary to meet such conditions and give satisfaction. It is economy in the end."

Since the conditions in different localities vary so greatly, there is no hard and fast rule to be applied in answering the question, "What kind of road shall we build?" Each case must be considered upon its own merits. Nevertheless, there are certain economic principles which can be applied to the design and construction of roads of all classes.

The following features may be said to govern the justifiable cost of any highway: (a) traffic requirements, i.e., volume, weight, and kind of traffic; (b) amount of money available for construction and maintenance.

Since any road is a failure which does not carry the traffic for which it was designed, the justifiable expenditure should be that which will produce satisfactory results under the service to which the road will be subjected.

The cost must not be regarded merely from the viewpoint of first cost but of first cost plus maintenance during the life of the road. The cost of initial construction is not the total cost of a highway. The prevailing opinion seems to be that once built a road is good for all time. No greater fallacy could be imagined. No road is ever completed in that sense, because it is at all times subject to the breaking down process of traffic wear and the deteriorating effects of the elements. Care and maintenance of a road must begin the day construction ends, and be religiously continued during the life of the road. Only in this way can the investment be preserved to the community. The maintenance then becomes a fixed charge which must be taken into account and provided for, and therefore, constitutes a part of the ultimate cost.

Generally speaking, the answer to the question of justifiable cost is, "Pay enough to obtain a road which experience has demonstrated will meet the requirements of the present and future traffic at a reasonable cost of upkeep." If there is not sufficient money on hand to do this, put the amount available into such vital features as proper location, drainage and subgrade. These constitute the foundation upon which every good road must be supported and are the only truly permanent features. Build upon this foundation as fast as means will permit, but build the foundation first.

In selecting any type of pavement, "service tests of roads subjected to similar conditions are the best criterion for guidance." We should study those road surfaces which have given the most satisfactory results and the most adequate returns for the money expended upon them and imitate the principles employed in their construction. Tried-out forms of construction, and the materials used therein, are, therefore, the best evidences of how a road should be built in the future. The experience of the older states along this line is particularly valuable and we should profit thereby. It would be an indefensible policy to repeat the mistakes or fail to imitate the successes of other communities where road building has had its evolution from the experimental stage.

The main features to be considered in the selection of any type of road surface are:

Traffic requirements, present and future.
Availability of suitable materials.
Permanence.
Ease of maintenance.
Cost—First cost and maintenance.

Traffic.—A mistake often made is the designing of a road to take care of the traffic requirements of the present only, with no regard for those of the future. A road which is satisfactory for present day needs may be totally inadequate for the requirements a few years hence. This is particularly true of motor traffic. Also the fact that an improved road attracts increased travel must not be overlooked.

A road should be so located and constructed as to be capable of permitting future surface improvements for increased duty without sacrificing any of the original construction.

Materials.—The cost of any type of surfaced road depends largely upon the availability of the materials required in its construction. A good road cannot be built with inferior materials. Accurate knowledge of the properties of the materials used, together with information and data in regard to experimental and practical usage are essential. If all of these factors are not properly considered, results will be uncertain. Many failures and large waste of public money can be charged to the element of experimental chance and lack of accurate knowledge. Highways built with borrowed money impose a grave responsibility upon the builders whose duty should be to so build that the results of their work will not become an unjust burden upon the next generation.

Permanence.—Strictly speaking, no road surface is permanent. The so-called permanent types of roads simply approach that state more or less closely, and their degree of permanence depends upon how well they are maintained. The ideal surface is the one which requires the least maintenance. The aim should be to build this kind of road, consistent with the money available. As heretofore stated, the truly permanent features of any road are in the location, drainage and subgrade, and the success of any kind of surface depends upon careful attention to these important principles which constitute the foundation.

Ease of Maintenance.—This, while a very desirable feature of road planning, cannot govern the selection of a type because the most easily maintained pave-

* By Edward St. C. Smith, Assoc. M. Soc. C. E., former State Highway Engineer of Idaho in Good Roads.

ments are usually the most expensive in first cost, representing an initial outlay and annual interest charge that is prohibitive to most communities. This fact, however, warrants the expenditure of an amount sufficient to maintain in first-class condition a surface of lower first cost.

Cost.—The most economical type of road is that for which the first cost, plus the cost of maintenance and interest on the investment for a given number of years, is a minimum. The comparatively high construction cost of one type of road might be entirely offset at the end of ten or fifteen years by the high maintenance cost of a cheaper and less permanent type of road. On the other hand, more money could be justifiably spent for maintenance on the cheaper type of road. For example, let us assume that a bituminous macadam road can be built for $10,000 per mile and suppose this to be paid for by 20-year bonds at 5 per cent. The annual charge for interest on and redemption of the bonds would be about $800. Add $100 per mile per year for maintenance and we have the sum of $900 per mile per year as the cost of the road to the community. Now, we will assume that a first-class gravel road can be built for $2,500 per mile. The annual charge for interest on and redemption of 20-year, 5 per cent. bonds would amount to about $200 per mile. Therefore, it is theoretically economical to spend $700 per mile per year for the maintenance of the gravel road if for that sum the road can be maintained in a condition giving as good service as the $10,000 road.

"The secret of successful road construction lies in the proper design, proper construction and the use of tried-out materials." The following points should be given careful attention: Location, subgrade, drainage, and adequate foundation for surface. These may be regarded as permanent features of construction.

For surface treatment a safe rule is, "Use materials and methods of construction demonstrated by previous experience and service tests, to be satisfactory and to give an adequate return for the money."

There is one factor that more than any other is responsible for better road construction, and that is the automobile. Highway commissioners and highway engineers are often criticised for building so-called automobile roads, but such criticism is unwarranted. The automobile has come to stay and it would be folly to ignore it by building roads for team traffic only. Furthermore, the time is almost here when the automobile will be just as much a part of the utility equipof a farm as horse-drawn vehicles. The only increase in cost of roads that can be charged directly to the automobile is the top course or surfacing. The horse-drawn vehicle is still a governing factor in the determination of grades.

The State of New York has been building hard-surfaced roads for many years and has had ample opportunity to observe the advantages and disadvantages of each type. Such experience and service tests extending over a period of a number of years is very valuable to any community taking up this problem. The following data are taken from a recent article by Edwin Duffey, Commissioner of Highways, State of New York.

Up until 1909 gravel and water-bound macadam, and in some few instances brick roads, were the only types of pavements considered. Subsequently, roads were built as follows:

		Water bound macadam	Bituminous macadam	Miscellaneous types
1911.....	943	19 per cent.	75 per cent.	6 per cent.
1912.....	1,422	25 "	45 "	30 "
1913.....	95	.. "	.. "	.. "
1914.....	1,152	35 "	32 "	33 "
1915.....	1,066	50 "	33 "	17 "

The facts shown by the above table are very significant and are remarkable in view of the great change in traffic conditions during the period covered. Note the steady increase from 19 per cent. to 50 per cent. in water-bound macadam construction when it was generally supposed that this type of pavement was a failure under motor traffic.

Commissioner Duffey further states: "These percentages will probably bear out the fact that instead of the water-bound macadam being superseded by bituminous penetration road, it has a distinct place of its own and to our minds is the best type of pavement for moderate traffic roads in rural localities."

It should be noted that the type of road referred to by Mr. Duffey is not a true water-bound macadam but a water-bound macadam with surface treatment to eliminate the dust and mud nuisance and disintegration of the top concrete. He says: "It has been found necessary to provide some sort of surface coat to prevent this preliminary wear and disintegration of the fine surface material. The use of calcium chloride for the first year is proving satisfactory in preventing the fine surface dust from being blown away or removed by automobiles." He states in conclusion: "Our present practice leads us to believe that water-bound macadam construction, including one treatment of calcium chloride in the contract followed by bituminous surface application the following year is a satisfactory type for moderate traffic on market roads."

Width.—A discussion of this subject would not be complete without touching upon the item of widths of roads, for the reason that width affects very materially the cost of construction and maintenance.

The question of how wide a road should be built involves the consideration of several things, but is governed primarily by the amount and character of the traffic. We will consider here only the width of the pavement. Practice has demonstrated that the total width, including the ditches, should not be less than 30 feet, regardless of the width to be paved. Whether a single or double track road is to be built depends upon the traffic to be anticipated. Unless a pavement is 20 or 24 feet wide the traffic will cling persistently to the centre of the road. The only thing that will force it from there is more traffic. There are two reasons for this: First, too much crown on a narrow road; second, the tendency to follow a rut.

A road carrying heavy traffic should be wide enough and have a crown light enough to encourage traffic to use the entire width of pavement. Only in this way can the life of the surface be increased, the maintenance cost reduced, and the road operated at its highest efficiency. It should be borne in mind that while a double track road costs proportionately more than a single track road, the maintenance cost per mile of the former is much less for the same volume of traffic.

General practice seems to have adopted a width of 9 or 10 feet for single track roads and 15 or 16 feet for double track roads. Intermediate widths of 12 and 14 feet have been tried out but experience seems to have shown that unless an ample double track width is provided, a single track road had better be built, because only the liberal widths will be regarded as

double track roads and the traffic will stay in the middle. The extra 3 or 4 feet increases the cost from 33 to 40 per cent. and is not used.

The narrow, so-called double track roads would perhaps be sufficient for team traffic with some few exceptions, but for motor traffic they are invitations to disaster for automobile drivers who think they can pass at 40 or 50 miles per hour and sometimes think wrong. Accidents of this kind are of almost daily occurrence. Roads should not be designed to encourage speedy and reckless driving, but such trings are inevitable and involve the lives of innocent people who must be protected. A road should either be wide enough to be safe for two vehicles or else be strictly a single track road.

A possible solution of the problem where, for financial reascns, single track roads must be built or the mileage cut down, would be to build the second or top course of macadam roads wider than the first course. In other words, extend the top course out over the earth shoulders for several feet on each side, using fine gravel or screenings. This outer strip would be used only for passing. Its duty would be very light and it would represent but a small percentage of the cost of the road.

No matter what type of road it is decided to build, the maximum possible expenditure is always limited by the availability of funds, or in other words, the ability of the community to pay for it. The justifiable expenditure within such means is then limited only by the value of the road to the community as a profit-sharing investment. And that is the way it should be regarded—as an investment—from which the annual saving in lower maintenance charges, in reduced cost of transportation, the increased value of farm lands, the increased volume of taxable valuation through further development of the country by new settlement and many other direct and indirect benefits which always result from good roads, will more than repay the annual cost of the improvement.

In most cases the communities are now paying each year as the cost of bad roads, more than would be required for interest on and retirement of a bond issue which would make possible satisfactory systems of good roads.

Strictly as an investment proposition based on decreased cost of transportation, maintenance and the saving in wear and tear on vehicles, the justifiable cost of an improved road is directly dependent upon the traffic, so that in planning a road system, the type of surface necessary for the main market roads would not be justified or necessary for the secondary roads or feeders, on account of the lighter traffic on the latter.

Whatever type of road is considered, the fact must not be overlooked that the cost of operation and maintenance is a continuing expense while the cost of construction is incurred but once, so that the type of road which costs the most to construct is not always the most expensive in the long run, nor is the one lowest in first cost always the cheapest in the end.

"The road which is truly the most economical is the one which gives the most profitable returns for the money invested in it."

How then shall a community know which is the best and most economical type of road surface suitable for its particular needs and conditions when considering improvements of this kind?

In the first place such information can be obtained only through a thorough investigation of all of the local conditions affecting the determination, such as the volume and character of traffic, both present and anticipated, the suitability of local construction materials, the limit of cost, and other matters.

These are matters to be investigated and determined by a competent highway engineer whose experience and observations are wide enough to render his report dependable and whose knowledge and familiarity with the characteristics of various types of pavements in actual service insure the reliability of his recommendations. Several states have passed laws providing that before a bond election can be called, such information must be obtained by a competent highway engineer and submitted to the proper autroities and if the bonds are voted the proceeds thereof must be expended under competent engineering supervision.

As a matter of good business procedure it is assumed that no local board or commission would make a tax levy or call a bond election for road improvement without first having the above facts and figures before them for public information.

As a corporation plans and builds a railroad, so should the representatives of a community plan and build a public work.

It is a business proposition demanding good business management.

B. C. Lumber Exhibit

Under the supervision of Mr. L. B. Beale, B. C. Lumber Commissioner for Eastern Canada, samples of B. C. lumber products are now on exhibition at the Builders' Exchange, Montreal. The exhibit consists of finished specimens of seven woods—Douglas fir, Sitka spruce, Western red cedar, Western soft and white pine, Western hemlock and Western larch, in doors, pannelling, moulding, and in fact in all the main forms of manufactured lumber. All the woods, except the doors are arranged on large frames, the upper portions of which contain photos showing the lumber from the forest to the finished article. The photos include mills and paper and pulp plants. Underneath are printed descriptions of each wood, giving their strength, values, uses, and other information. The exhibit is part of the publicity campaign of the B. C. Government to push the sale of B. C. lumber in the east. Much aggressive work has been done in this direction, and a considerable number of promises to specify and use B. C. lumber has been obtained from architects and contractors.

Canadian Section Wins Prize

At the recent meeting of the American Waterworks Association, at which a considerable number of Canadian engineers were present, the cup offered by the president for the largest percentage of new members, was awarded to the Canadian section, which is in process of being formed. The section will probably hold a meeting in the fall. The cup was handed to Mr. H. G. Hunter, Montreal, of the New York Continental Jewel Filtration Company.

The city of Montreal propose to obtain from the purchasing department a report on the extent, facilities, and material, of all quarries and deposits of gravel and sand on the Island of Montreal. This is for the purpose of checking tenders for supplies of the various materials.

Fig. 1—The new Welland Ship Canal, showing its course in relation to the old and present canals. The new waterway will be 25 miles long and equipped with seven locks, each 800 feet long and with 46½ ft. lift.

Progress of the Welland Ship Canal

Work is going forward steadily in spite of shortage of labor and material—Harbour fill and excavation well advanced—Concentrating on first seven miles which includes all locks—Keeping within cost estimates

THE greatest engineering project under way in Canada at the present time, is the new Welland Ship Canal, connecting Lake Erie with Lake Ontario. Started late in 1913, construction has been carried on unceasingly. The canal, when completed, will accommodate vessels up to 800 feet in length, and with a 25-foot draft. It will be 25 miles long and contains 7 locks, each with a lift of 46½ feet. It will probably take 6 years to construct, and the expenditure necessary for its completion will involve approximately $50,000,000.

As an economic feature in Canada's development, a canal across the Niagara Peninsula is a requirement of foremost importance. The great difference in level between Lake Erie and Lake Ontario prevents through transportation by a natural waterway, and it was clearly recognized early in the last century that for economic reasons alone, an artificial cut across the peninsula would be required to make the lakes of anything greater than local importance.

Historical

The new canal is the third connecting link to be constructed between the two lakes. The possibilities of development of inland waterways traffic do not appear to have been realized at the time of the building of the original canal, which was commenced in 1824 and completed about nine years later. This canal was one of the first in Canada. As it had locks of wood only 100 feet long, 22 feet wide, and 9 feet deep, the natural expansion brought about by increasing development soon necessitated a more extensive scheme. So, in 1841, this found expression in the enlargement of the waterway by the construction of new masonry locks with entrance locks at Port Colborne and Port Dalhousie. A further deepening to 10 feet was carried out in 1860 and the bottom width of the canal was increased to about 26 feet. The locks, as finally arranged in the original canal numbered 27, of which 24 were 150 ft. by 26½ ft., the remaining three being 200, 230, and 270 ft. by 45 ft. respectively. This canal is still in existence, being used chiefly for power purposes.

In 1872, a re-design was again effected, resulting in the canal at present in operation. The old location between Allanburg and Port Colborne, a distance of fifteen miles, was maintained, the canal prism being widened and deepened. A new location was selected between Allanburg and Port Dalhousie, a distance of 11¾ miles, the route going slightly to the east, but coming out in Lake Ontario at the same point as the original canal. Its length is 26¾ miles, and to overcome the difference in level of 327 ft. between Thorold and Port Dalhousie, comprises 25 locks, the dimensions of which are 270 feet by 45 feet, with a depth of 14 feet of water on the sills.

So great had the Great Lake traffic grown and so

Fig. 2—Lock Section of the new Welland Canal, showing location of locks, bridges and pondage areas.

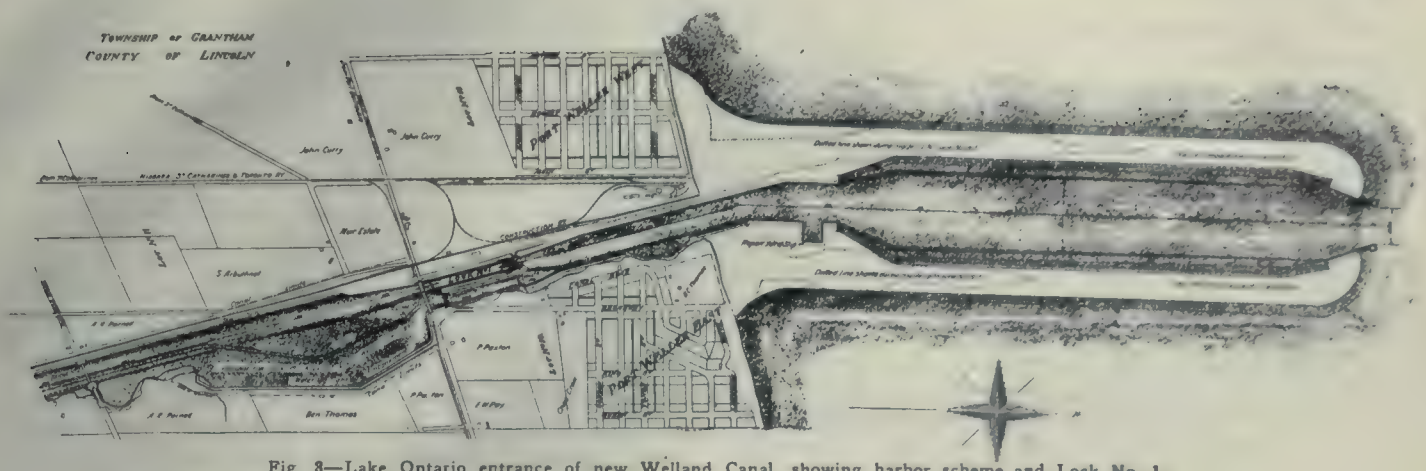


Fig. 3—Lake Ontario entrance of new Welland Canal, showing harbor scheme and Lock No. 1.

changed had the types and sizes of vessels become that it was many years ago realized that the present canal would be antiquated in the near future. The new canal was therefore proposed and has for its object the affording of greater and better accommodation for a larger class of vessels than can be used on the present waterway.

The New Canal

The new plan involves an entire reconstruction and a realignment in part to a more suitable location. The canal as finally located follows the course of the present canal from Port Colborne on Lake Erie to Allanburg, half way across the peninsula. From this point an entirely new cutting is to be made, crossing the present canal just below lock No. 25, the waterlevel of the two canals at this point being the same, viz., 568 feet above sea level. The new canal again crosses the present one below lock No. 11, the water of both canals at this point being at an elevation of 382 feet above sea level.

The canal enters Lake Ontario at the mouth of Ten Mile Creek, about three miles east of Port Dalhousie. The total length of the canal from lake to lake is 25 miles. The difference in level between the two lakes, 325½ feet, is to be overcome by seven lift locks, each having a lift of 46½ feet. The dimensions of the locks

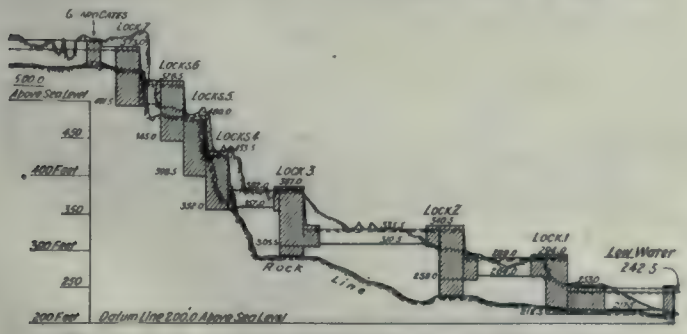


Fig. 4—Profile of Lock Section of the new Welland Canal.

are 800 feet in length by 80 feet in width in the clear and with 30 feet of water over the mitre sills at extreme low stages in the lakes. The width of the canal at the bottom will be 200 feet and, for the present, the canal reaches will be excavated to a depth of 25 feet only, but all structures will be sunk to the 30-foot depth, so that the canal can be deepened to this figure at any future date by dredging out the reaches.

Relative Locations of Three Canals

The map in Fig. 1 shows the relative locations of the three waterways. The new canal will be able to accommodate any vessels that are at present operating on the lakes, and it has been made of such a size as to keep pace with the natural growth that is bound to take place in both the size of vessels and volume of traffic. A new western breakwater will be built at Port Colborne, the Lake Erie entrance of the canal, to ensure quiet water in the harbor during storm, consisting of a gigantic rubble mound of stone from the excavation north of Port Colborne, terminating in a timber and concrete head-block located some 2 000 ft. further out in the lake than the present breakwater.

At Port Colborne the outer harbor is at present 22 feet deep at normal stages of the lake. The deepening of this portion of the harbor will therefore be left for the present and until the connecting channels of the Great Lakes admit of deeper navigation. The inner harbor will be deepened to the proposed new depth of 25 feet. The old locks and regulating weir now in the centre of the village will be entirely removed.

Wherever the new canal follows the present location, the cut will be deepened and widened by excavating along the western bank. A bend in the present canal, known as Ramey's bend, just below Humberstone, will be eliminated by making a fresh cut. The rock from this will be utilized in the construction of the Port Colborne breakwater. In this new cut, a guard lock will be built and a regulating weir will be installed in the abandoned part of the present canal so that it can be used as a by-pass to furnish water to the canal. The lock and weir will control the elevation of the summit level of the canal, which will be maintained at the level of extreme low water in Lake Erie, 568 ft. above sea level. As far as the town of Welland, the old course will be widened and deepened. The Welland River, where it crosses the canal is lower than Lake Erie and in the present canal an aqueduct carries the canal over the river. In the proposed work, a dam and regulating weir are to be built across the river at Port Robinson, which will raise its level to that of the summit level of the canal. The weir will control the elevation of the summit level, and allow any excess water to overflow into the old Welland River and be discharged into the Niagara at Chippewa.

Below Welland the bank at present between the canal and the river will be removed. From a little below Welland to Port Robinson, the course of the Welland River will be employed as being straighter and requiring less excavation. At Port Robinson, the present canal route will be again followed, a cut being made in the bank between it and the river. The "Deep cut" between Port Robinson and Allanburg will be deepened and widened by excavating on the west side. Work is proceeding on this now.

At Allanburg the original and present canals meet,

and a weir is located to supply water to the old canal for power purposes. This weir has been replaced by a weir opposite lock No. 25, on the present canal. The old waterway is being filled in between Allanburg and this new supply weir, and the ground between the old and present canals at this point, is being utilized as a dumping ground for the material excavated from the new cuts.

The "Lock" Sections

The portion of the new waterway between Thorold and Lake Ontario contains all the locks and is an entire relocation involving new excavations and constructions. It is of this portion only that the following article treats. Work on this portion is progressing very favorably. Fig. 2 illustrates the lock section in greater detail than Fig. 1. The location of the locks, seven in all, is indicated.

The new course crosses the present canal again at lock 11, at an elevation of 382 ft. above sea level. Small vessels may use the Port Dalhousie entrance, and the present canal, and join the new canal at this point. From lock No. 4 the new canal follows, in the main, the bed of Ten Mile Creek, entering Lake Ontario at the mouth of this stream, about three miles east of Port Dalhousie.

Lock Dimensions

The locks are uniform in size, and their dimensions are 800 ft. long by 80 ft. wide, with a normal water depth of 30 ft. The walls will be 82 ft. above the top of the sills. For each lock a pondage area is being provided, to be utilized as a storage and regulating basin from which water to fill the lock is to be drawn. This method of drawing water from a side pond instead of directly from the canal, obviates the formation of objectionable currents and surges in the canal and locks, and saves time. This method is being used for filling all of the locks.

The Locks

Following the course of the new canal from Port Colborne northward, the first lock encountered is known as No. 7, situated at Thorold, the north end of the Erie level. A pair of twin guard gates will be located here near the southerly limits of the town of Thorold as a special protection to the summit level. These gates are a short distance south of lock No. 7, the head of which lock is directly opposite the head of lock No. 24 of the present canal. A regulating basin for lock No. 7 will be formed of that portion of the present canal lying between locks Nos. 25 and 24 together with a pond of some 27 acres created by flooding the upper valley of Ten Mile Creek.

Below lock No. 7 is a short reach of canal with an adjacent side pond having a surface area of about 84 acres, and immediately below this, locks Nos. 6, 5, and 4, in flight, are located. These three locks overcome a descent of 139½ ft. In order to give locks Nos. 4, 5, and 6 a traffic capacity equal to the other single locks, these are built in twin flights, one for up-bound and the other for down-bound traffic, the total flight being regulated to minimize long delays in the passage of vessels through the canal.

The location of the next lock, No. 3, is directly north of the present canal and at its head to the east side is situated the equalizing basin, a pond of 150 acres. Some difficulty was experienced in finding a location for this lock on account of insufficiency of rock for foundations. Below lock No. 3 a heavy cutting is required through the village of Homer to the bed of the Ten mile Creek.

Below Carleton Street, lock No. 2 is located. The pond at the head of this lock, at an elevation of 335½ ft. above sea level, floods about two hundred acres of land in and adjoining the bed of the Ten Mile Creek.

Below lock No. 2 the canal follows the bed of the creek to the lake, lock No. 1 being situated just below the Lake Road, and but a short distance from the entrance to Lake Ontario. The pondage at the head of lock No. 1 covers an area of 170 acres.

The locks are constructed throughout of concrete set on bedrock. The lock walls rise 82 ft. above the top of the lower gate sill, and, including the necessary foundation work required below this level, two of the locks, Nos. 2 and 3, have walls 100 ft. or higher; at No. 2 a 17-foot excavation was necessary to reach rock, and at No. 3, the walls are 68 ft. down.

The Lock Gates

A notable feature of the lock gates is that they are of the single-leaf type. They will be constructed so as to swing on a hinge at one side of the lock, resting,

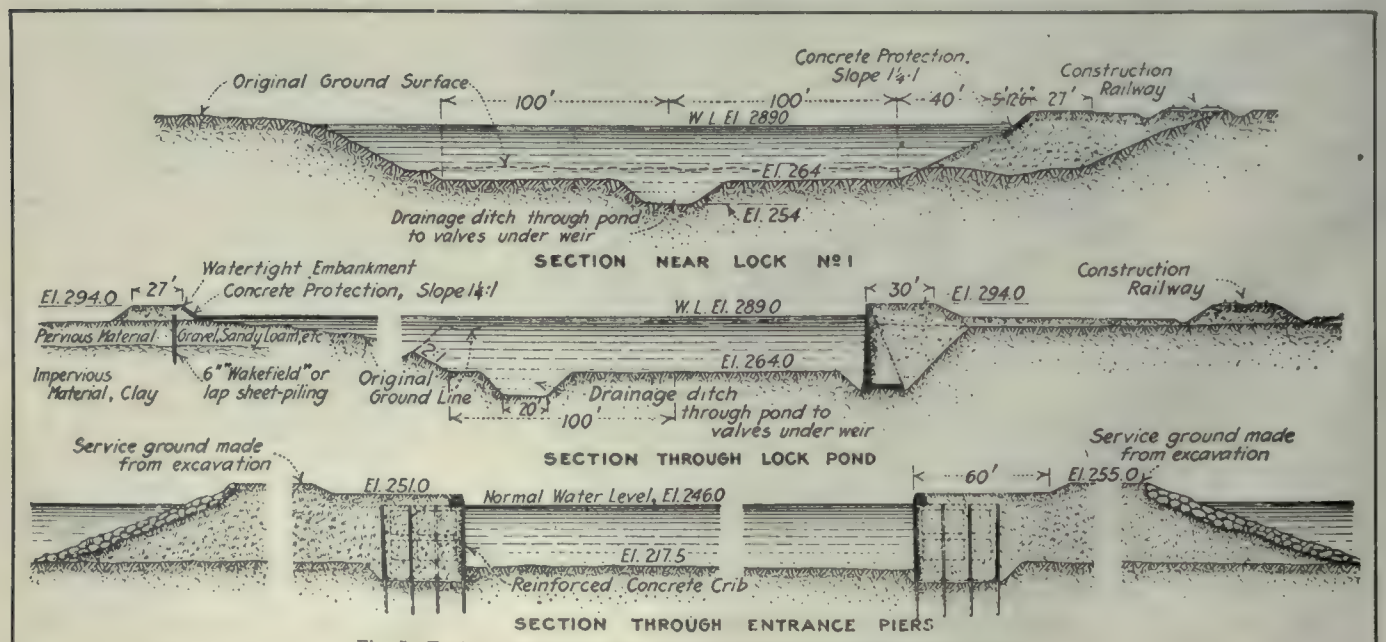


Fig. 5—Typical Sections through the new Welland Canal near Lock No. 1.

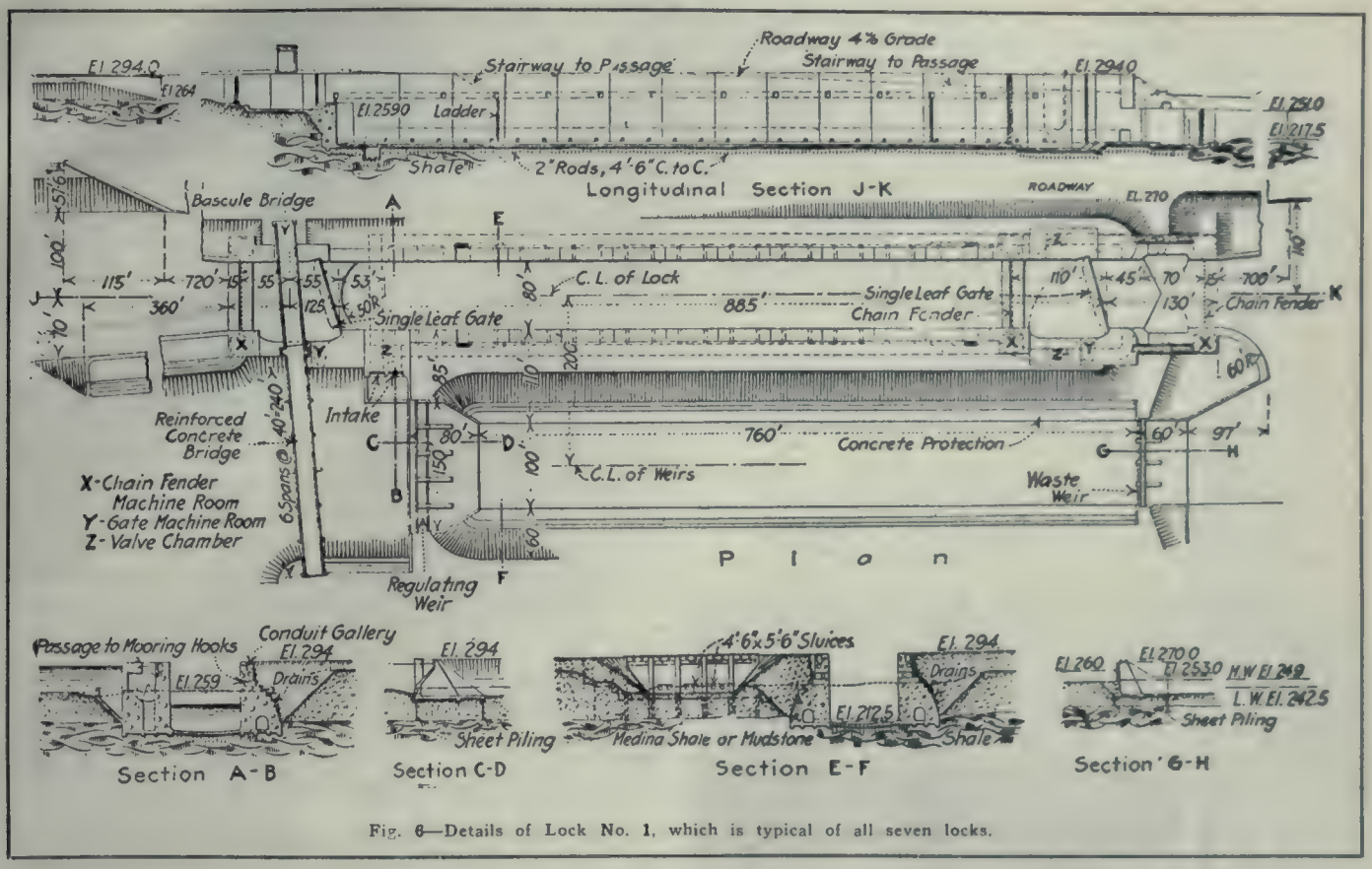


Fig. 6—Details of Lock No. 1, which is typical of all seven locks.

when open, in a recess cut in the wall. The gate at the foot of each lock will have a height of 83 ft., a length of 90 ft., and a weight of about 1,125 tons. The upper gate will be only approximately half as high, as it is located on top of the breast wall. The valves and culverts, as designed, will allow a lock to be filled in less than eight minutes. The details are described elsewhere.

Section of Canal Lock

Fig. 5 illustrates a section of the canal near lock No. 1; also a section through the lock pond. In Fig. 6 details of lock No. 1 are shown, these being typical of all the others. The chief features to be noted in Fig. 6 are the regulating channel to the side of the main lock, with its two weirs, dividing the total fall; the single-leaf gates; the chain guards or fenders above and below the gates; the culvert connections between pond and lock, and the concrete bridge, with draw-span, across the lock.

Watering the Locks

The locks are made of concrete sidewalls and floor with concave breast walls carrying the upper gates. A regulating channel or reservoir is built beside each lock to supply a large volume of water quickly and act as a by-pass. A regulating weir at entry and a waste weir at exit of each lock controls the water. Two arch culverts, 14 ft. x 16½ ft., one in each side wall and running its full length, serve to fill the canal through 3 ft. x 4 ft. lateral passages placed at short intervals and connecting this main culvert with the lock. One of these passages is shown in illustration Fig. 23. A concrete funnel under the floor of the lock connects the two culverts of each lock together. A valve system controls the passage of water from the regulating channel to the culvert.

The regulating chamber, or reservoir, has earth walls with concrete slab or rip-rap protection. The stretches of canal between locks have concrete protection at the water line, Fig. 10, extending 5 ft. above and 5 ft. below water level. This protection is 18 in. thick, 9 in. of foundation and 9 in. of concrete. In locks Nos. 4, 5, and 6, which are excavated almost wholly out of a good quality of sandstone, the lock chambers are formed by facing the rock with several feet of concrete. This method makes the use of side culverts difficult and bottom culverts will be installed.

Lake Ontario Entrance

The Lake Ontario entrance arrangements are specially noteworthy. To get a ship channel from the lake to the canal required dredging the lake bottom for 1½ miles from shore, where the depth of water is 30 feet. The method adopted for constructing the Lake Ontario harbor is to run out two parallel earth embankments extending from the original shore line to a point 1½ miles out and dredge a shipway between them. By this "fill" a large area of land is reclaimed, which will be used as industrial sites. At the same time, a splendid harbor is provided. The harbor will be 1,000 ft. wide, with the mouth narrowing to 400 feet. The earth fill on each side will be 500 feet wide. These embankments will be protected by rough rip-rap for the greater portion of their length, but there are portions which are being protected on the inside with reinforced concrete cribs. These will provide vertical faces for the mooring of ships and, at the outer end where the embankments converge, will give a navigating channel for the full width between embankments. Fig. 3 gives a plan view of this scheme, and in Fig. 5 a section is shown.

The cribs which are used for forming the walls are built on shore at Port Dalhousie, towed into position and then sunk on prepared positions. The embank-

ments are formed from the material excavated from the canal cuts up as far as lock No. 3. At the present time, the fill has reached the outer limit on one side and is within a few hundred feet of the limit on the other side. Port Weller is the name that has been given to this new town site created by a fill of some 5,000,000 cubic yards of earth and stone.

Methods of Construction

The Harbor Work

The whole work is divided into nine sections on which construction has been, or will be, independently let by contract. The first section includes the entrance piers and lock No. 1.

To construct the Port Weller works, temporary trestles were built, one on each side, on which the cars of excavated material could be run in order to dump their material on the required spot. These

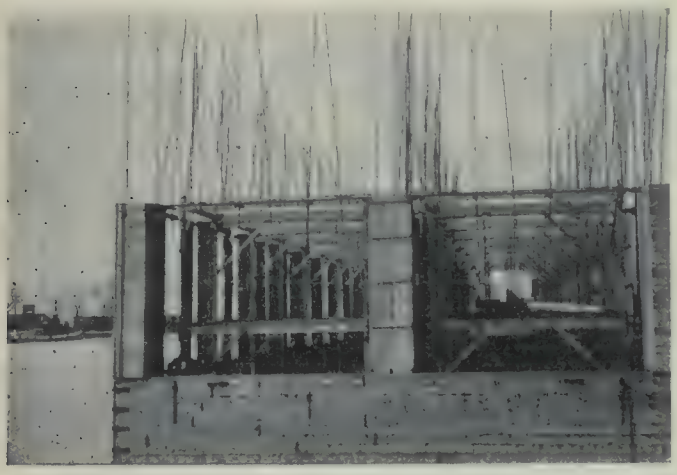


Fig. 8—Reinforced concrete crib construction, showing floating pontoon and reinforcing.

trestles consisted of pile bents spaced 15 feet apart, each bent containing four piles. Until a depth of 10 or 12 feet of water was reached, the piles were driven directly into the lake bottom, after which they were capped and braced. The stringers were then laid upon them at an elevation of about 10 ft. above water, and the contractor who was to use these trestles laid his own track upon these stringers, and commenced his dump. The earth was dumped up to the level of the bottom of the ties, when the "spreader" was brought into service, by means of which the earth dumped was gradually widened out for a distance of about 15 feet on each side of the trestle. The track was then shifted off the trestle on to one or other of the side dumps, until by continuous dumping, spreading and moving of track, the embankment was widened out to required dimensions. As soon as the track had been moved off the trestle the contractor removed the stringers from that portion of the trestle and used them on a new portion which had been driven farther out in the lake; the remainder of the trestle was left buried in the embankment.

Beyond a depth of 10 or 12 ft. an under-water embankment was built on the lake bottom in the line of the trestle by bringing the scowfuls of excavated material from the dredging in the harbor and dumping them, after the scows had been carefully pushed as close as possible to the previous dump. In this way an underwater embankment was built up to within about 9 or 10 ft. of the surface of the water, and through this embankment the piles forming the bents were driven, extending 2 or 3 ft. into the lake bottom below. By the use of this underwater embankment the trestle was stiffened considerably in the deep water.

The whole system of forming the embankment in the lake in this manner has proven very satisfactory, and while there have been a few cases where the material, after being built up to the level of the track, has slid away, carrying portions of the trestle with it, these troubles have not been of a very serious nature. The embankments so far have held up splendidly, and very little loss has been caused by the action of the water.

The Cribs

The cribs used for protecting the sides of the harbors are of special interest. The general form of the crib is seen in Fig. 9. The total length of each crib is 110 feet 4 inches, the width 38 feet, and the depth 34 feet. Each is divided into 18 compartments or pockets by means of one longitudinal centre wall and eight cross walls.

The end and side walls extend from top to bottom without an opening of any description. The interior walls have a rectangular opening 8 ft. x 14 ft., the bottom of which is 12 ft. from the top of the crib. The purpose of these openings is to reduce the weight of the crib, and since they are near the top, to bring the centre of gravity lower down. Thus each pocket is separated from those adjoining for a depth of 22 ft., and it is intended that each shall be watertight. Watertightness is important, since the crib is required to float during construction and possibly for some considerable time after it is built. By separating the lower portion of the openings, only one or two pockets are flooded in case of a leak and the crib will merely incline from the vertical instead of sinking. Moreover, the openings in the interior walls are high enough to keep water from flowing from a flooded compartment to a dry one, except when sinking. Each pocket is provided with a temporary wooden floor or bottom.

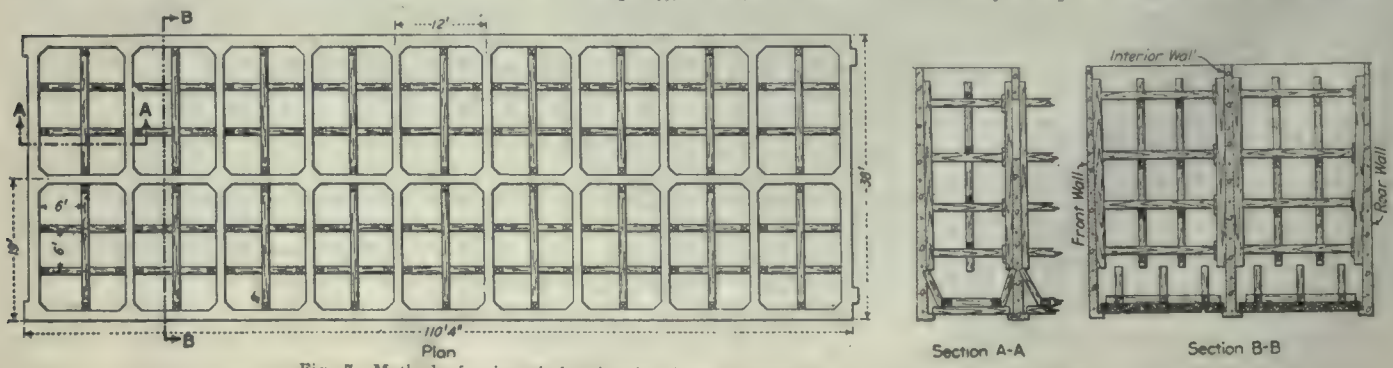


Fig. 7—Method of using timber bracing in the pockets of the reinforced concrete crib.

:s distant.

wedged in place in such a way that after the structure is sunk they can be pulled out by chains.

Crib Construction

The cribs are built in pontoons at Port Dalhousie, three miles from their final location, and the temporary wooden floors inserted, towed to position and placed upon windrows of broken stone. The pontoon is simply a rectangular box, open at the top, whose inside dimensions are those of the outside of the crib, with a depth of 9 ft. The pontoon is built in knock-down form, so that when the crib is finished, and the temporary bottoms are inserted, it can be taken off. This is done by unscrewing the sides and ends and allowing them to float away, and allowing the bottom, which has been previously ballasted, to sink away. Inside the floating pontoon are built the forms for the lower portions of the walls, the sides of the pontoon acting as a part of the form work. As the walls rise, the pontoon sinks deeper and deeper and finally disappears below the surface owing to the continually increasing weight sustained by it, the sides of the crib above the pontoon serving to keep the water out. The temporary bottoms are placed after the form work in the pockets has been removed.

A watertight joint is made between the temporary bottom and the concrete ledge upon which it rests by

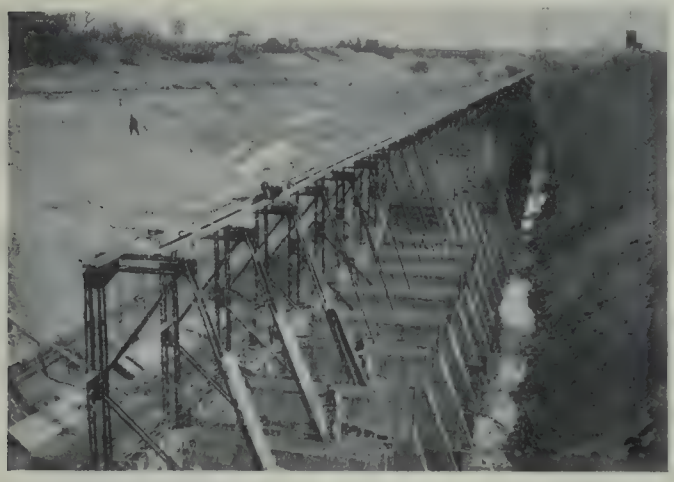


Fig. 11—Construction of lower west entrance wall, Lock 1, showing steel supporting frames.

placing between them a rope made of jute yarn covered with canvas, which is tightly squeeezd down by the wedges that serve to hold the bottom in place. On the construction work which has already been accomplished, the contractors have poured the concrete in lifts of 3 ft., alternately placing the horizontal reinforcing steel in position for each lift and pouring concrete. The vertical steel extending from top to bottom without a break must be placed before any concrete is poured.. Fig. 8 shows the construction, with the floating pontoon and reinforcing.

The cribs are floated to the positions prepared for them. The seat for each crib is dredged a little below the required grade and then three windrows of broken stone are placed and levelled off, one row under each of the front, centre and rear longitudinal walls. Water is admitted slowly into the compartments until the crib is within a few inches of the bottom, and after adjusting into exact position and line, a little more water brings it to rest on the rows of stone. Interlocking ribs are provided on the ends of the cribs to key the adjoining ones.

After the crib has reached its proper position, the false bottoms are removed by releasing the wedges and the crib is filled with spoil. The use of temporary bottoms is for the sake of economy, because they save concrete and can be used over and over again. Also, the bottomless cribs allow the filling to rest on lake bottom, tending to prevent settlement, and the rows of stone secure an even bearing. Fifty-three of these cribs will be used altogether.

An investigation of the forces acting on the crib shows that the design must take into account three different conditions of loading on the walls: (1) The exterior water loads on the floating crib; (2) the exterior and interior water loads on the sinking crib, and (3) the interior fill loads on the submerged crib when it is in its final position and during filling. An analysis of these loadings reveals large loads carried by the walls due to the water pressure when the crib is sinking. These act for a comparatively short interval of time, and it seemed that if some scheme could be devised for bracing the walls while the crib is sinking that a very considerable saving in reinforcing steel could be effected.

The scheme adopted is to use timber bracing wedged into the pockets. For plan of bracing see Fig. 7. It is placed before admitting water and removed before the pockets are filled with earth. The bracing is arranged in such a way that the spans over which the water loads act are reduced to 6 ft., and hence the bending moment and therefore the steel necessary, are considerably reduced. The drawing shows the arrangement of the bracing in detail. It is seen that without this bracing the spans of the front, rear and centre longitudinal walls are 12 ft., and of the end and cross walls 18 ft. When it is remembered that the bending moment varies directly as the product of the square of the span and the load per unit of span, the effect of the bracing in reducing the quantity of reinforcing steel is apparent.

The reinforcing steel is in the form of plain round rods, Fig. 8, and the spacing has been confined to multiples of 6 in., as some little aid in standardization and simplicity in construction. For the same reason the size of rods is confined to ¾ and ⅞-in. diameters. Each crib requires 934 cu. yds. of concrete and 112,000 lbs. of steel.

Fig. 11 shows the west entrance wall of lock No. 1 during construction, and Fig. 22 indicates its completed appearance. This is a reinforced concrete retaining wall of the buttress type, 42 feet high. It is founded on rock, and extends from near the present shoreline to the foot of lock No. 1, a distance of 1,640 ft. It is constructed in monoliths of 100 ft. each in length. In the construction of this wall, triangular steel frames, 41½ ft. in height (Fig. 11), were utilized, and erected at 12-foot intervals, one in each buttress, their purpose being mainly as a support for the reinforcing bars, and for the contractors' forms. The frames were punched to correspond with the system of reinforcing the wall, and the rods threaded through the holes. This method ensured the rods being placed exactly where they were required, and that none were omitted. It was not considered that the frames themselves, with the exception of the back legs, bear any material part in the reinforcing of the wall, but experience has shown that their use was amply justified for the purpose for which they were designed.

It is of interest to note that the wing walls now under construction have discarded this construction for mass concrete, chiefly due to changed market conditions.

In Figs. 14, 15, 21 and 23, the method of construct-

Fig. 12—Welland Ship Canal. Channelling sides of rock cutting. The excavation for the twin locks 4, 5 and 6.

Fig. 13—Welland Ship Canal. Building earth dam around concrete core-wall to form reservoir.

ing the lock walls is illustrated. These are made in monoliths of about 60 ft. in length, of mass concrete and "plums."

The main filling culverts, which are 14 ft. wide by 16½ ft. high, are being built into the side walls by means of collapsible steel forms, 60 ft. in length (Fig. 14. On the completion of a monolith to a height of 5 feet above the culvert, and after allowing a couple of days for setting of the concrete, the form is slightly collapsed by means of turn-buckles and moved forward on rails into position for the next monolith. Wooden forms are used for the 3 foot and 4 foot laterals connecting the main culvert with the lock. A "lateral" is shown in Fig. 23. Steel panel forms are

Fig. 14—Construction of Wing Walls, Lock 3, showing steel culvert forms, —July 1, 1916.

being used for the face of the lock wall. Fig. 15 shows the forms in place for the laterals, and in Fig. 14 the forms for the culverts can be seen.

The Breast Walls

In excavating for the breast wall at lock No. 2, the method adopted was to drive a wall of steel sheet piling, 45 feet long, to refusal around the site, the piling being braced with heavy wooden timbers as the excavating proceeded. The steel piling was driven to an average penetration of 33 feet, until excavation in the pit had been carried on to a considerable depth, when the piles were re-driven to their full length. The excavation of the pit was largely done by hand, owing to the confined working area due to the interior bracing.

This method of building the breast wall was adopted in order to conserve the ground above the breast wall in its natural state, as, had the lock pit been excavated in the usual manner it would have been open for several months, during which time slides would undoubtedly have occurred, which would have prevented a satisfactory treatment of that portion above the breast wall, whereas the method adopted will leave the material above the breast wall intact. The material excavated from the lock area of the lower level was removed by a drag-line, and the steel piles were drawn with a fifty-ton, 5-sheave block and tackle, suspended from a timber A-frame standing on top of the wall, and operated by a steam hoist. The steel sheet piling on the sides of the walls and on the back was left in place as permanent protection.

An exactly similar course was followed in lock No. 3, except that building paper was placed between the concrete and the piling which was to be removed. This greatly facilitated the pulling operation.

The Welland division of the Grand Trunk Railway was situated at a point where the twin locks are located. This necessitated a diversion of the line to the west. As the line here climbs the Niagara escarpment at 1.7 per cent. grade, the work was very heavy, involving the removal in all of 48,000 cubic yards of rock and 43,300 cubic yards of earth excavation within a distance of two miles.

A temporary diversion of the main line was also required. This diversion, which consisted in moving a portion of the double-track main line about 50 feet to the north, where it crosses the site of twin locks No. 4, was rendered necessary in order to carry the double-track main line of the Grand Trunk Railway over the works during construction and to allow free passage beneath the railway for the excavated material from the lock pits to the stone crusher, located just north of the main line, and to Lake Ontario. In order that this diversion might be finally disposed of and cause no further trouble to the Grand Trunk Railway Co. or to the contractors, the centre pier upon which one end of these steel spans rest, has been sunk through earth and rock, a depth of 90 feet, to the level of the foundation of the locks, and it will be eventually incorporated in the centre wall of the locks. The side piers have been sunk to about two-thirds of this depth, to the surface of the rock below. This will allow the contractors to excavate the lock pit completely without interfering with the bridge, and allow the lock walls to be built. When the locks are completed, two bascule lift bridges will be placed on the original line of the Grand Trunk Railway and the line replaced in its former position. The temporary spans will then be removed. Instead of building double-track spans four single-track spans have been constructed, the idea being that they will be easier to sell upon the completion of the work than a double-track structure.

The largest cut on the entire work is that required for the twin locks in flight, Nos. 4, 5, and 6. This has meant extensive rock excavation. Fig. 12 shows a

Fig. 15—Construction of wing wall, showing the forms in place for the culvert and laterals.

partial view of this cutting. In blasting out these cuts, the drill holes are bored by electrically operated drills. Holes 20 to 40 feet in depth are drilled in rows at intervals of 18 feet parallel to and 18 feet at right angles to the centre line of the canal. As many as fifty-seven of these holes have been fired at one time, and as each hole contains several cases of dynamite, the total charge fired has amounted on several occasions to about 13 tons.

In order that the rock in this section may not be disturbed beyond the contemplated lines of excavation,

Fig. 16—Welland Ship Canal. Loading wagons with material for watertight embankment.

Fig. 17—Welland Ship Canal. Upper end of pit for Lock No. 2, showing breast wall surrounded by sheet steel piling. Photo midsummer, 1915.

Fig. 18—Welland Ship Canal.. 150,000 tons of crushed rock.

the method adopted has been to channel the rock along the final lines to be excavated. The illustration in Fig. 12 shows the channelling machine at work. The method of close drilling was used to some extent, but it has been found that this does not make a good face.

Another feature of the excavation at this point is the installation of a rock-crushing plant, erected by the contractors under the terms of their contract to crush stone excavated from this section and supply it for concrete to contractors for sections Nos. 1 and 2. One of the illustrations shows the plant in operation. A reserve stock pile of approximately 150,000 tons has been accumulated, from which to furnish stone when the crusher is idle or when the demand for same becomes very heavy. During periods of temporary breakdowns of the crushing plant, and when its capacity was not sufficient, rock from the excavation has been dumped in large quantities in a storage pile just north of the crusher to be re-handled later to the crusher as required.

Concrete Protection to Banks

Concrete protection has been applied to the banks of the canal. This consists of a 9-inch slab of concrete laid on a layer of broken stone, and will extend from 5 ft. below water to 5 ft. above water. The foot of the slab will rest on a horizontal 5-foot berm and will have a 1¼ to 1 slope.

All the excavated slopes above water level are being sodded, as it is a cheap and efficient method of protecting the slopes after trimming. In order to hold the sods in places, pegs are driven through them into the slope, and the results obtained have been very successful. Slopes of embankments are allowed to settle for a year before trimming and sodding.

The Washing Plant

Among the numerous construction developments which necessity forced upon the engineers of the Welland Canal, one of the most interesting is the newly erected crushed stone washing plant. As already noted, the excavation taken from the site of locks 4, 5, and 6 is solid rock, which is delivered to a huge crusher, capable of accommodating anything from about 2 cubic yards down. Having passed this first crusher the stone is elevated into the crushing plant proper, where it is further reduced to normal size by

Fig. 19—Stone washing plant to remove dirt from crushed stone.

the ordinary crushing process. Until within recent months the stone was again elevated either to a storage bin, from which the cars are loaded, or to the large surplus pile shown in Fig. 18. Recently, however, it was decided that the permanence of the con-

Fig. 20—Welland Ship Canal. Spreader at work on Harbour Embankment.

struction work of the canal would be best served by thoroughly washing the crushed stone to remove a certain percentage of soil and fine stone content. This led Chief Engineer Weller and his staff to devise the washing plant, described below, which has recently been placed in operation and is shown, in one view, in Fig. 19.

The washing plant, though of entirely local and home-made construction, is doing wonderfully satisfactory work. Two elevators, one leading direct from

J. L. Weller, Chief Engineer, Welland Canal System.

the crusher, the other from the storage pile, carry the crushed stone to the top of the structure shown in Fig. 19. These elevators may be used simultaneously or separately, as conditions require. Both of the elevators deliver the stone into a central hopper from which it is distributed to four separate screen-troughs, placed in relation to one another as the four semi-diagonals of a square and inclined downward at an angle of approximately 45°. These screen-troughs are approximately 15 feet long by 3 feet wide, a fairly fine screen constituting the flooring of the lower two-thirds of each trough. The upper part of each trough is provided with obstacle projections which spread out the stone as it passed down and thoroughly mixes it with water which is sprayed upon it copiously at high pressure.

The spraying arrangements are the secret of the success of the whole plant. To this end iron pipes, some 3 inches internal diameter and 3 feet long, and provided with a row of small holes to allow the passage out of the water, are placed at intervals of about 12 inches horizontally across the top of the trough and a few inches from it. The sprinkler pipes over each of the four screen troughs are interconnected by a main feed pipe and the 4 mains are fed by a 12-inch pipe line, which runs back a mile and a half to the next lock in the present canal, so that the water is delivered against the stone, as it passes down the screen troughs, at high pressure. The spraying tubes are also turned at various angles, thus ensuring a clean surface all round.

A second quartette of screen troughs, placed lower down, catch and direct the crushed stone back and down to a central common bin, while the water, and its mud content, pass off by a waste trough and is delivered into the canal which lies close at hand. In Fig. 19 this water waste trough is shown prominently in the foreground.

Sand Supply

Another feature of the efficiency methods being observed in the prosecution of this work is in connection with the sand supply. The Government engineers have been particularly careful of the quality of sand used in the concrete work and the supply is now being

obtained, by dredging, near the mouth of the Niagara River and carried by scows into Port Weller harbor. Here it is elevated by crane hoist to large storage bins built over the railway tracks. The sand is then loaded on the railway cars through bottom hopper doors and distributed at various points along the line.

The Construction Railways

Throughout the length of the lock end of the canal a standard gauge construction railway has been built to carry excavated material to the lake, haul stone and plums from section 3 to sections 1 and 2, to distribute material, and so on. The line is equipped with a complete interlocking and block signal system and a telephone train dispatching system, and is about 7½ miles long. It was built by the Government for use by the various contractors.

An idea of the size of the work may be further obtained when it is estimated that 2,500,000 barrels of cement will be required, all told.

Excavating Plant

A great variety of excavating plant is in use along the canal on the sections now under contract. The submarine excavation entails the use of floating drill boats, dipper dredges, clam shell dredges and hydraulic suction dredges. These are tended by a fleet of powerful tugs and dump scows, the majority of the latter being of 500 cubic yards capacity.

The dry excavation is being handled principally by steam shovels, varying in size from the small 20-ton to the large 90-ton, having buckets of from 1½ to 4½ cubic yards' capacity. A considerable amount of excavation has been by means of modern drag-line excavating machines. These shovels and drag-lines are tended by a very efficient train service consisting of a large number of locomotives of all sizes and styles and many different varieties of dump cars, from the 4-yard narrow gauge car to the 20-yard modern steel air dump car. There are also trains of flat cars, unloaded by means of "Lidgerwood" unloaders. On the dumps in the lake and elsewhere there are miles of trackage to take care of the enormous output of all these machines, and "spreaders" of several varieties are being constantly used, pushing the excavated ma-

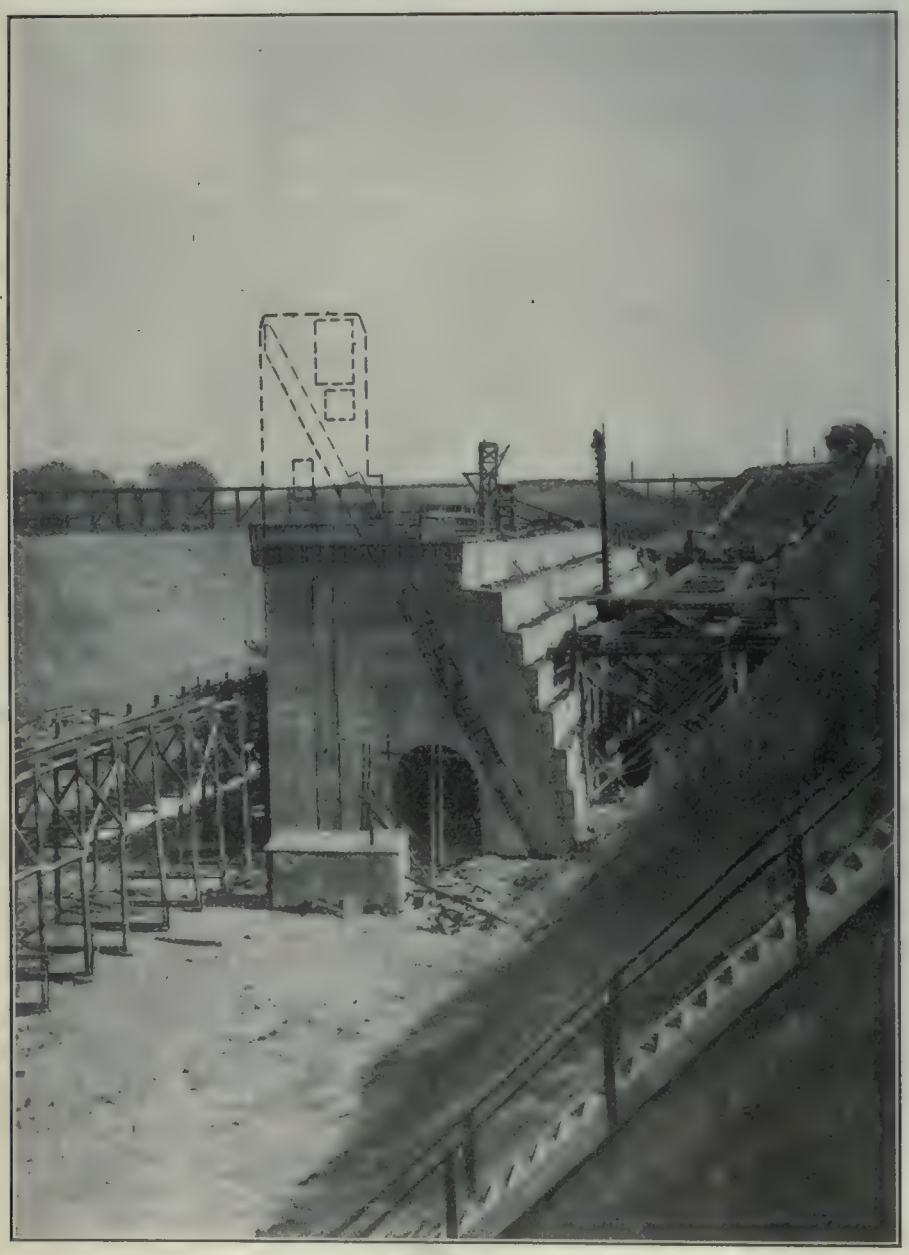


Fig. 21—West Wall, Lock No. 1 (34 feet yet to be built shown dotted). This view was taken July 1, 1915. The concrete work on this lock is now nearly complete.

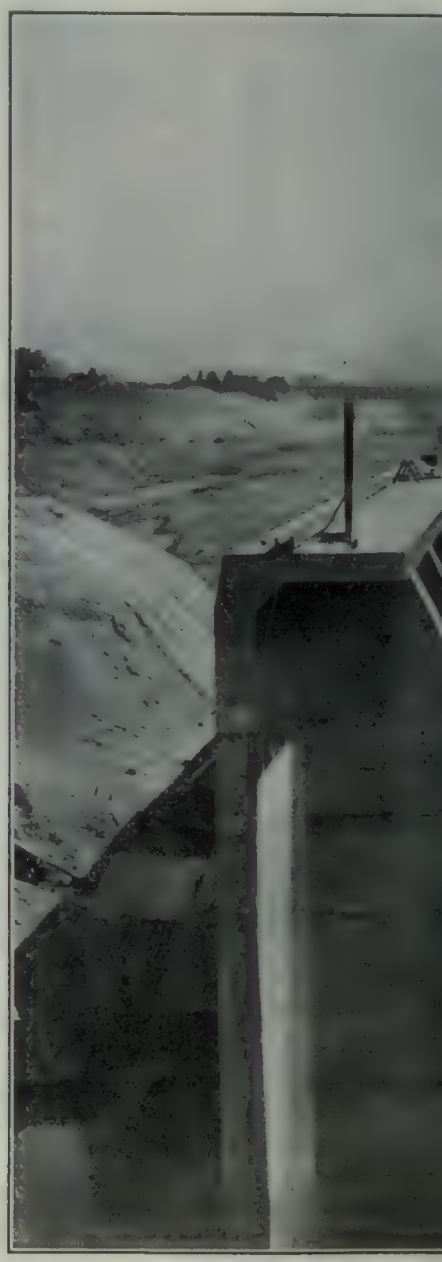


Fig. 22—Welland Ship Canal. No. 1. Photo taken during

terial over the site of the fills and levelling up the dumps. More than 1,100 car loads have been placed in the west embankment of the harbor in one day.

As much of the material excavated is clay of the consistency of soft putty, which often drops out of the cars in solid lumps of 10 or 12 yards each, the spreaders have a most interesting time in tearing this to pieces and getting it out of the way.

There are several grading machines also in use. Most of these are hauled by traction engines. These machines plough up a furrow which is turned from the plough share on to a belt running at right angles to the machine and operated from the wheels of the latter. The belt is at an angle of about 30 degrees with the horizontal, and elevates the material to such a height that when it falls over the roller at the top of the belt it will drop into the dump wagons which follow alongside the machine. When one wagon is full the machine stops, the wagon keeps driving on and another takes its place, and as soon as the wagon box arrives under the end of the belt the machine is started and the operation continued with very little delay to the actual loading. The wagons hold 1½ cubic yards, are self-dumping and are easily hauled by a team of three mules. On this work all the material so excavated has been used to make watertight embankments, the earth being dumped into the embankment in layers of about 8 inches, which are thoroughly watered and compactly rolled by the wagons driving over them. These machines have been averaging nearly 10,000 cubic yards per month each.

A certain amount of excavation has been done by locomotive cranes, handling clam shell buckets. The large earth dam at the head of lock No. 6 is being built by drag line machines, one of which has a boom 115 ft. long. These machines are equipped with large clam shell buckets instead of the ordinary drag-line bucket, and are re-handling the earth which has been dumped on either side of the dam site, into the dam. These machines travel on the dam itself, building it up in layers of about 8 inches, which are spread as much as possible by opening the clam shell while the boom is still swinging. After a section has been spread in this way it is levelled off by teams and scrapers and

ete Entrance Wall, Lock
ing in summer, 1915.

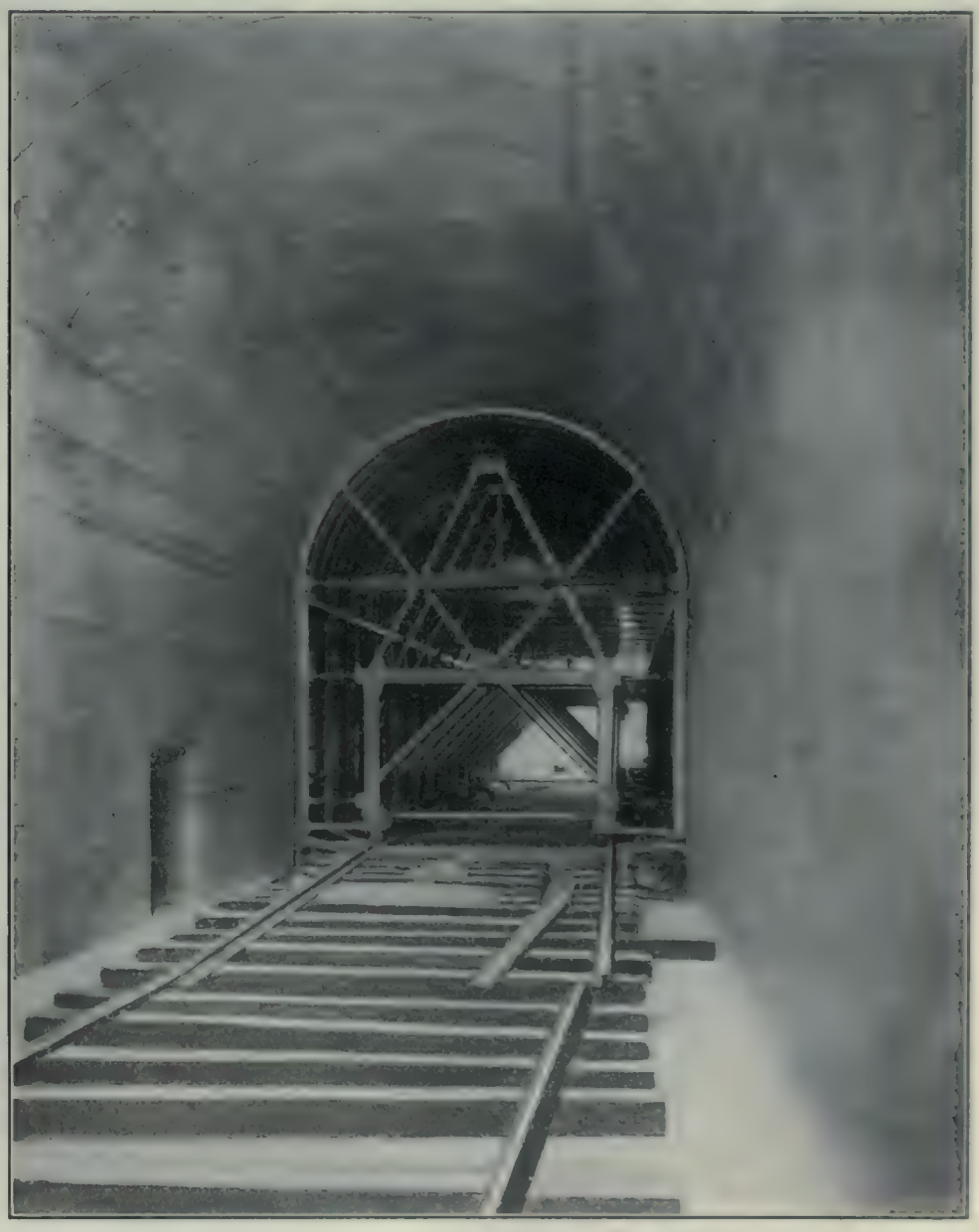


Fig. 23—Welland Ship Canal. Interior of filling culvert in West Wall of Lock No. 1. Size 14 ft. x 16½ ft. Note one of the by-passes on the left connecting with lock chamber.

then watered and rolled by large traction engines having wide tread wheels.

Miscellaneous Equipment

There are also in operation through the whole length of the work a large number of cranes, both stationary and locomotive. Well drills are used quite extensively for drilling purposes, a rock drill for submarine excavation, and a great variety of mixers, including gravity mixers. The scope of the undertaking affords ample opportunity for studying the comparative merits of different types of equipment and in this regard it might be stated that the usefulness of the gravity mixer is being carefully observed.

The Contractors

Section No. 1, which is under contract to the Dominion Dredging Company, Limited, consists principally of the construction of the new harbor at the Lake Ontario entrance to the canal, which covers 1½ miles of dredging in the lake, and considerable pier work; 1½ miles of canal excavation inland, and the construction of lock No. 1, with its weirs and entrance walls. The value of this contract is $3,500,000. It involves little rock excavation. All material is used for filling in the harbor. The principal rock encountered is an outcropping along the bottom of the harbor entrance some 1,700 ft. long and 22 ft. below water level This will require a 3 ft. excavation, or approximately 150,000 cu. yds., for which drilling operations are at present under way. The work on lock No. 1 is well advanced, practically all the concrete being placed.

Section No. 2 was awarded to Messrs. Baldry, Yerburgh and Huchinson, St. Catharines, at a price of $5,500,000. It includes, in addition to the excavation of the canal prism, the construction of locks Nos. 2 and 3, with their regulating and waste weirs, the substructure of four bridges, in addition to the one over the head of lock No. 2, and a large number of watertight embankments. The work will be practically all earth excavation to the extent of about 6,500,000 cubic yards. Locks 2 and 3 are well under way..

Section No. 3, although only two miles in length, was valued at $10,220,615, Messrs. O'Brien & Doheny and Quinlan & Robertson being the contractors. It consists principally of the excavation of 2,700,000 cubic yards of rock and 3,400,000 cubic yards of earth; the diversion of the Grand Trunk Railway, Welland division, which was rendered necessary in order to obtain satisfactory location for the canal; the building of a large earth dam with concrete core wall; the building of twin locks Nos. 4, 5, and 6 in flight, and single lock No. 7, which, together with their entrance walls, etc., will contain about 1,200,000 cubic yards of concrete. The contract also comprises the crushing and furnishing of about one and a quarter million tons of stone for concrete for sections Nos. 1 and 2. The views herewith show the extent to which excavation work on Nos. 4, 5, and 6 is advanced. Practically no concrete has been placed except that the upper entrance walls of No. 6 are completed. The excavation for Nos. 4, 5, 6, and 7, is proceeding.

Section No. 5 was awarded to the Canadian Dredging Co. at about $2,000,000. It extends from Allanburg to Port Robinson, and is just under two miles in length. The work consists mainly of deepening and widening the present cut. About 2,500,000 cubic yards require excavating.

Who Supplied the Equipment

Much of the equipment at present in use in the Canal construction work was not purchased new when this work began, but we give below a list of machinery in use which we believe to be fairly complete and accurate:—

Three of the locomotives were manufactured by the American Locomotive Co., of New York, and four by the Vulcan Iron Works, Wilkesbarre, Pa.; large locomotive cranes, manufactured by the Brown Hoisting Machinery Co., of Cleveland, and the "Industrial Works," Bay City, Mich., supplied by F. H. Hopkins & Co.; the steam shovels are "Bucyrus" and "Marion" type, supplied by F. H. Hopkins & Co., Montreal; culvert and wall forms, Blaw Steel Construction Co.; sheet steel piling, Lackawanna Steel Co., Lackawanna, N. Y.; hoisting engines, M. Beatty & Sons, Limited, Welland, Ont., also "National" hoisting engines for extra heavy derrick work, supplied by F. H. Hopkins & Co.; hoisting crane, McMyler Interstate Co., Cleveland; rock drills, Keystone Driller Co., Beaver Falls, Pa., supplied by F. H. Hopkins & Co.; Napanee Tripod Drills; concrete mixers, T. L. Smith Co., Milwaukee; gravity concrete mixers, Automatic Co., Providence, R.I.; batch mixers, Ransome Concrete Machinery Co., Dunellen, N.J., supplied by F. H. Hopkins & Co., Montreal; spreaders in use on harbor embankments, O. F. Jordan Co., Chicago; drills on drill boat in harbor—type H. 64, Ingersoll Rand Co.; submarine drill motors, Canadian Westinghouse Co., Hamilton; centrifugal and piston pumps, Smart-Turner Mfg. Co., Hamilton; air dump cars, Western Wheel Scraper Co., Aurora, Ill., also Kilbourne & Jacobs air dump cars, supplied by F. H. Hopkins & Co.; traction engines, Sawyer, Massey Co., Hamilton, Ont.; pumps, (Section 3) A. S. Cameron Steam Pump Works, New York; Channelling machines, Sullivan Machinery Co., Chicago; compressors and rock drills, Canadian Ingersoll Rand Co., Toronto; cement, Canada Cement Co.; selective train dispatching and blocking system, Northern Electric Co., Montreal; several steel bridges, Hamilton Bridge Works Co., Hamilton; 150-ton railway track scale, Gurney Scale Co., Hamilton; mechanical interlocking plant and blocking signal system, Saxby & Farmer, Limited, Montreal.

The Montreal Trade and Labor Council has taken strong exception to the statements recently made in a report by the city engineer's department as to the excessive cost of day labor as against contract work. The claim made by the Council speakers was that contractors' work was not as permanent as that done by day labor, that extras were often unnecessarily made, and that labor conditions were not as favorable. One of the delegates admitted that under day labor the existing patronage system added to the cost, as relatives and friends of the aldermen were placed on the pay roll for doing work about which they had no knowledge. Foremen were interfered with and threatened with dismissal if they did not act in accordance with the wishes of some aldermen.

A question of a mistake in a tender, on account of the successful bidder not properly understanding the specifications in French, came before the Montreal Board of Control. The Dominion Architectural Iron Works, Limited, bid on two fire escapes to be erected at the City Hall, and being the lowest tenderers were awarded the contract. The company afterwards wrote that a mistake had been made, owing to the French specifications not being understood; the controllers, however, have decided that the company must carry out the contract, or failing this, the work will be done by the next lowest bidder and the difference charged to the company.

Bearing Value of Soils for Foundations

The following extracts are taken from a report submitted at the annual meeting of the American Society of Civil Engineers by a special committee appointed "to Codify Present Practice on the Bearing Value of Soils for Foundations and Report Upon the Physical Characteristics of Soils in Their Relation to Engineering Structures. It is a timely subject:

The Genesis of Soils

In the development of the earth's crust, rocks have been formed by the aggregation and consolidation of various materials. Those rocks in their turn have been subjected to physical disintegration and chemical decomposition by atmospheric and other natural agencies, called rock-weathering. Some of the residual products of rock-weathering are the unconsolidated clays, silts, sands and gravels, etc., which cover the surface of the underlying rock and are here defined as the soil. Thus, the soil has the same mineralogical constituents as the rocks from which it has been derived, except where chemical action has leached out the less resisting minerals.

The relative predominance of physical disintegration or chemical decomposition will vary with the locality. For instance, under the influence of moisture and heat, chemical decomposition will predominate in humid tropical regions, where the heavy clay soils occur; and physical disintegration is the dominant process in arid and arctic climates. Consequently, the properties of the soils will vary, although they may be formed from the same kind of rock. For example, the granite rocks of the humid Appalachians of the South form a fine-grained soil, and similar granites of the arid Sierras form a coarse granular product.

Physical Disintegration

The process of physical disintegration of rock is concerned with: (1) Temperature changes, by unequal expansion and contraction of the rock minerals from heat and cold. A frequent repetition of this action, or a sudden change in temperature, causes the crumbling of the exposed surfaces of the rock. The effect is greatest where the diurnal or seasonal range of temperature is a maximum. The maximum diurnal range of temperature occurs in desert regions, and the maximum seasonal range in northern climates. (2) Alternate expansion and contraction from freezing and thawing the interstitial water in the pore-spaces of the rock. (3) The abrasive action of flowing water or wave action, when carrying sediment. (4) The action of the wind, when projecting fine soil particles against rocks. (5) Glacial action in crushing and comminuting rocks into "glacial flour," and the formation of moraines, etc., from rock debris. (6) In a limited degree, by the action of organic life.

Chemical Decomposition

The process of decomposition is largely concerned with the chemical action of water and air. The most important chemical reactions are: (1) Hydration, (2) carbonation, (3) oxidation, and (4) solution. These reactions usually cause an increase in volume of, and the disintegration of, the rock minerals. As an increase in temperature also increases the solvent power of water, a warm, moist climate is most favorable to the chemical decomposition of rocks; whereas the mechanical processes of soil formation are more noticeable in dry and cold climates.

Physical Composition

From the physical point of view, the particles of soil vary in size and shape. The sizes of particles may be grouped tentatively in five primary grades; shingle, pebbles, grit, dust and flour; but each may be arranged in corse, medium, and fine subdivisions.

Separations into uniform size-grades are made by the wet sifting process. Sheet-metal screens having circular openings have been adopted tentatively, and are used for the coarse grit grades and larger. Hydraulic methods are used for separating the medium grit grades and finer.

Shape of Particles

The particles of soil may have flat, sharp, or normal, angular, rounded, or corroded surfaces. As the largest diameter of a soil particle determines the size-grade in which it will be placed, it is evident that the shape of the particle will have considerable influence; for example, if a shot was flattened, the size of the hole through which it would then pass would be greatly increased. The presence of flat particles in soils which have been derived from micaceous and other rocks will differentiate the soil from the ordinary soil as indicated by the mechanical analysis.

Mineralogical Composition

The mineralogical nature of the soil largely depends on the rock from which it has been derived, through the mechanical or chemical processes of formation. In the soils of the arid and glacial regions a variety of minerals is usually found; and in the humid regions quartz and the hard minerals predominate. Such soft material as talc, kaolinite, chlorite, and mica may exercise a decided influence on the cohesive and other physical characteristics of soils, especially in landslides or soils under pressure, and in the presence of considerable moisture.

Chemical Composition

Chemically speaking, the soil varies with its mineral constituents; but differences in chemical composition have a very limited physical effect, and may be practically disregarded, except, possibly, to distinguish between calcareous, alkaline, ferruginous, or siliceous soils.

Physical Properties

The physical properties which have the most important influence in soil classification are (a) water content, (b) texture, and (c) structure.

Water Content

It has been shown by Cameron and Gallagher, in laboratory investigations, that the magnitude of any physical measurement of soil changes varies with the water content. The extent of the variation is influenced by the texture, that is, fine-texture soils are more influenced than those of coarse texture; furthermore, there is a critical water content at which the physical properties of soil attain either a maximum or minimum value.

The percentages of moisture in soils are tentatively

proposed for classification purposes as follows:—

Degree	Percentage by Weight.
Humid	0% to 5%
Damp	5% to 10%
Moist	10% to 15%
Wet	15% to 25%
Saturated	25% +

Texture

Texture refers to the relative proportion of the different size-grades of particles, and is constant. Thus, it is a property that can be used as a basis of classification. Moreover, it is an important factor on which many physical properties depend. According to texture, soils are arbitrarily separated into such classes as sandy, sandy loam, loam, clay loam, clay, etc. The presence of larger fragments of rocks and variations in the shape of particles will modify the textural class. The number of textural classes that shall be made must depend on the differences in physical properties, as influenced by the size-grades, and the extent to which it is desired to carry the divisions.

The larger textural classes may be subdivided, or adapted to any amount of detail, but, as it is probable that other soils may be found of similar mechanical composition, it is here emphasized that other properties than texture must be considered for a satisfactory classification.

Structure

Structure refers to the arrangement of the particles, and is a variable property. It may be loose and porous or compact and impervious.

The structure of a very coarse sand or gravel cannot be materially altered. The particles, in the main, function individually; and they have a sufficient mass so that they fit together in such a way as to give about the same degree of porosity.

Clay soil, on the other hand, may fit very loosely or be very compact; the particles may be largely separated and free, or may be gathered together in groups which function together as a single large particle. There may be large and small pores, as when, in a puddled clay, the mass has been mixed together in contact with water; then the spaces between the large particles are filled in successively by smaller and smaller particles, and a very dense and impervious mass results. This condition is aimed at by the ceramist, who desires such cohesion of this product as will render it rigid and impervious, that is, a thoroughly puddled condition.

Classification of Soils

In any study relating to natural objects, a satisfactory classification is always difficult to arrange, because the various elements merge into others by almost imperceptible gradations. No sharp lines or divisions exist, and such as are made must be more or less aribtrary. Soils have been variously classified under geological, vegetative, chemical, climatic, and other classifications, no one of which is entirely satisfactory from an engineering point of view. Yet, accurate information in regard to the nature of soils is so fundamental that classification is necessary for interpreting their characteristics and the final solution of the problems in soil physics. For this purpose, the essential factors that produce differences in soils should be arranged in the order of their influence, and, at the same time, the ready identification of these properties in the field is of the greatest importance. At present it is not practicable to prescribe definitely the limits of particular class groups. Future study and discussion are required to account for difference concerning the materials in any of the groups.

As rocks are the source of the soil constituents, differences in soils may be traced to two groups of factors: First, soil-forming material; and second, the processes by which rocks have been changed into soil.

With reference to differences in soils which are due to the soil-forming material factor, these depend on the kind of rock from which the soil has been derived. This would lead to a classifying of soils as granite, sand-soils, shale, slate, marl, marble, or limestone soils; but, as has been pointed out, the same kind of rock does not always give the same kind of soil, so that this one factor is incomplete in itself.

In connection with the second factor—the processes of formation—soils are classified as sedentary soils, which are derived directly from the degeneration of the underlying rock, and transported soils, which are derived from unconsolidated material and transported since it was broken down. These may be further sub-divided into colluvial (gravity-laid), alluvial (water-laid), aeolian (wind-laid), and glacial (ice-laid). The different agencies in the transportation of soil material determine to a large extent its character.

The system of classification to which attention is here invited is largely based on differences in the physical properties of soils.

(1) Soil-Forming Material and Processes

The soil-forming material and processes of formation are here understood as the broadest bases in the physical division of soils. The sedentary and transported soils are recognized as representing the first factor in the division of soils.

(a) Residual soils (formed in place) include all those produced by the decay of the soil-forming material from distinctly consolidated rocks, and which decay has progressed so that large bodies of soil are derived therefrom. These are sometimes referred to as granite, etc., soils.

(b) Cumulose soils have been formed in place from the accumulation of organic matter. Their engineering significance is quite limited.

(c) Colluvial or gravity-laid soils are formed by the accumulation of soil material by gravity without the appreciable co-operation of any other force. They include cliff and talus debris, and accumulations on hillsides and undulating uplands, etc.

(d) Alluvial or water-laid soils are formed by the sedimentation of soil material transported, sorted, and deposited entirely by water, whether laid down by rivers, lakes, or oceans. They include river alluvium loess, and adobe in part, estuarian clays, salt marsh and swamp deposits, sea beach sand, etc.

(e) Aeolian or wind-laid soils are formed by the transportation, sorting, and depositing of soil material by wind. They include sand dunes, or lakes and seashore, loess and adobe in part, volcanic dust, etc.

(f) Glacial or ice-laid soils are formed by pulverization, transportation, mixing, and depositing of soil material by glacial action. They include glacial drift, till or boulder clay, morainal deposits, etc.

(2) Water Content

The water content of soils, when determined as "moisture equivalent" or by evaporation, in percentage of the weight of a unit volume, is recognized as the second important factor in the division of soils.

(3) Special Condition

This includes a group of properties, any one of

which may be used as the basis for the third factor in the division of soils.

These properties may be:—

(a) Mineralogical—When the physics of the soil are affected by the mineral constituents;

Or as of a calcareous, alkaline, silicious, or ferruginous nature.

(b) Structure.—When open or porous; compact or impervious.

(4) Texture

The texture of the soil material is recognized as the fourth factor in the division of soils. The percentages of size-grade limits have yet to be quantitatively determined.

The names proposed for the foregoing factors in the division of soils are as follows:

(1) Source of soil material ... ... Group
(2) Water content ... ...Series
(3) Special conditions ... ... Phase
(4) Texture ... ... Class

The combination of these factors will determine the type, which is the unit of soil classification. The soil type may be defined as including all that soil material which is approximately alike in source of soil material, moisture content, special condition, and texture.

Your Committee does not consider that this is the final classification, but it is submitted with the view of discovering its weaknesses. Nevertheless, it is believed that it is the proper basis on which any soil classification must be formulated.

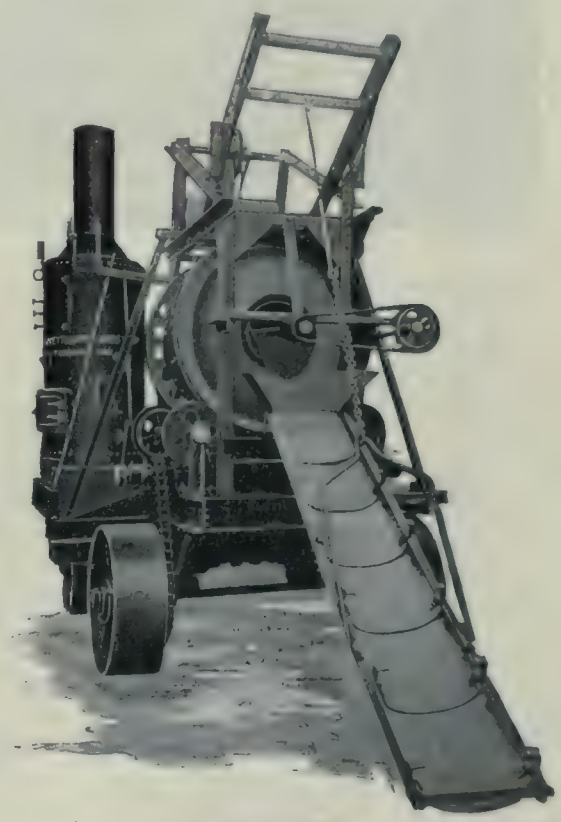
The study of the physics of soils includes a certain amount of laboratory investigation, and your Committee having found that the procedure in use by agronomists is not satisfactory, it became necessary to undertake much experimental and original work. A great deal of time and expense has been devoted to these studies, which include: the sizes, gradation, and mineralogical composition of soil particles; the proper and best form of screen; the development of inexpensive apparatus for field and laboratory use for soil analysis; the theory and design of centrifugal elutriation methods, etc., etc. This work has not progressed sufficiently to make a report at this time. Developing standard methods for laboratory procedure is necessarily quite expensive and time-consuming, so much so that your Committee was obliged to curtail its work on account of the exhaustion of the funds available. In this connection your Committee expresses a deep appreciation for past support and encouragement by the Board of Directors, without which the work already accomplished would have been impracticable.

Whitby Hospital Well Advanced

The new hospital for the treatment of mental diseases, situated near Whitby, Ont., is now nearing completion. This institution, which is under the control of the Ontario Government, stands on a site not far from Lake Ontario, comprising some 650 acres of Government land. In laying out the hospital the cottage system was adopted, and at present there is one group for men patients and a second for women. These two groups, which may be extended later to meet requirements, each consist of eight cottages with an additional building to be used as an infirmary. Each group has its dining quarters and kitchen in a separate building. The hospital will accommodate 1,800 patients, with a possibility of extension. The cost of the plant is in the neighborhood of one and a quarter million dollars. It was designed by James Govan, of Toronto, the Government architect.

New Road Paving Mixer

Wettlaufer Bros., 178 Spadina Avenue, have brought out a new paving mixer, which is illustrated herewith. This mixer, while built specially for road paving, is being used successfully on different kinds of concrete work. Among the special features to which the manufacturers draw attention, are:—(1) Elevated drum; (2) direct connected oval bottom hopper; (3) rear discharge; (4) sectional delivery chute; (5) traction drive (both wheels); (6) two speeds, forward and reverse; (7) reversible link motion engines; (8) no intermediate hopper to clog up.



New Paving Mixer.

The new machine is said to be very fast. The manufacturers state that the hopper delivers in 8 seconds, and the drum discharges a complete batch in 14 seconds. The elevated drum insures a positive stream of concrete down the distributing chute. The mixer is equipped with a strong water tank which allows you to measure the water accurately for any size batch of concrete. The machine control allows you to traction very slow or fast, as the case may be, when going over rough roads, steep hills, or from one job to another.

Have 32 Licensees

The Shawmut Paving Brick Works, of Shawmut, Pa., and the Pennsylvania Clay Company, of Pittsburgh, Pa., have become licensees of the Dunn Wire-Cut Lug Brick Company. The Shawmut company has an approximate daily capacity of 30,000 paving brick, but the company is contemplating the enlargement of the plant to a 50,000 daily capacity. The Pennsylvania Clay Company has one plant at Conway, Pa., with a capacity of 60,000; one plant at Crow's Run, with a capacity of 60,000, and one plant at Brady's Run, Pa., with a capacity of 40,000. The acquisition of these two companies gives the Dunn Wire-Cut Lug Brick Company 32 licensees, operating 52 plants.

Footbridge at Granby for the Miner Rubber Co.

Unique Footbridge at Granby, Que.

The footbridge shown in the photograph on this page was installed by the Miner Rubber Company, of Granby, to connect their factory on the south side with Cowie Road, leading directly to the centre of the town on the north side of the River Yamaska. At the same time the officials of the company saw the advantages to be obtained so far as the public were concerned by selecting a location for the bridge to serve the purpose of a public footbridge between the two sides of the river, about half a mile below the nearest means of communication existing. The site of the existing timber structure was therefore abandoned, as this had access on the one side only by going through the company's factory. The final location leads directly to Dennison Avenue, running parallel with the river on the south side.

The principal dimensions of the structure are:—Centre span 112 ft. x 11 ft. deep, and the two end spans 60 ft. x 5 ft. deep. One end of the centre span is supported on a trestle bent 15 ft. high and the other three points of support rest directly on concrete piers. The bridge has a slope of 1 in 12 and although this necessitated the use of stairs at both ends, it was not considered wise to increase same on account of the slippery conditions prevailing in the winter season. The width of the bridge was made 9 ft. centres of trusses, this being considered a minimum width desirable for the stability of the centre span. The public spirit shown by the Miner Rubber Company has resulted in the township desiring to have a hand in the proceedings, and the bridge has now been taken over by the municipality.

The manufacture and erection of the bridge were carried out by MacKinnon, Holmes & Co., Limited, of Sherbrooke, Que., who also designed the structure.

Well Known Contractor Passes

Mr. Michael A. Pigott, Hamilton, Ontario, died at his home in that city on July 5. Mr. Pigott was born in 1850 in Trafalgar Township, Halton County, the son of Michael Pigott, of Westmeath, Ireland, and Jane Flood, of Trafalgar Township. He was widely known and universally respected in the contracting business, where he had been engaged on a large scale for some 40 years. During this time he was associated with such important public works as the Grenville Canal; the Meaford harbor; the Guelph and Goderich Railway; Deering Harvester plant, Hamilton; Hamilton City Hall and Government Armories; Grey Nuns' Hospital Saskatoon, and many other public buildings of various kinds in Quebec, Ontario, Manitoba, Saskatchewan, and Alberta. During the construction of the Grey Nuns' Hospital in Saskatoon, in 1912, Mr. Pigott suffered a slight stroke and has since been forced to lead a quiet, simple life at his home in Hamilton.

Mr. Pigott was a genuinely self-made man, leaving his father's farm in his early 20's with nothing but his health and strength. He made rapid progress by sheer ability and force of character, until he was known and respected all over the country. He leaves a wife and five grown sons and daughters—Joseph and Roy, of Detroit; the Misses Regina and Frances, at home, and Mrs. John A. Gerety, of Philadelphia.

Mainly Constructional

East and West—From Coast to Coast

The Toronto city council have guaranteed the harbor commission bonds to the extent of $1,500,000.

The town council of Sackville, N. B., voted $5,000 for the construction of sidewalks, at a recent meeting.

The surveys of the Ottawa-Prescott highway have already begun. It is expected that the work will occupy about ten weeks.

At a recent meeting of the council of Windsor, Ont., by-laws were carried authorizing the construction of pavement on a number of streets.

Extensions of the waterworks system of the town of Galt, Ont., are proposed, and tenders for trenching, pipe laying and refilling are asked for.

The Canadian Comstock Company, Limited, has been incorporated with a capital of $40,000, and will carry on a general contracting business, headquarters in Montreal.

Building permits to the value of $65,775 were issued at Sault Ste. Marie, Ont., for the first six months of this year, as against $29,250 for the corresponding period last year.

The value of building permits issued in St. John, N. B., in June, was $56,250, against $27,200 for the same period last year. For the half year ending June 30, 1916, the figures were $301,950; like period in 1915, $169,050.

Hon. Robert Rogers, Minister of Public Works, recently

inspected the Toronto Harbor work. He expressed himself as satisfied with the progress made by the contractors.

The council of Port Credit, Ont., have been discussing the question of building a town hall. All the members seem to be in favor of the erection of a suitable building.

Contracts amounting to $23,000 were recently let in the province of Manitoba by the Good Roads Board, according to a statement made by Highways Commissioner A. McGillivray.

The I. C. R. flour shed at St. John, N. B., off Smythe Street, with thousands of dollars worth of goods, was destroyed recently by fire. The loss is roughly estimated at $75,000.

It is proposed to pave Davenport Road, Toronto. With the use of macadam the cost would probably reach some $108,000. The ratepayers, however, do not favor that class of pavement.

A new bridge is to be built over the Valley River, near Dauphin, Man. It will be of steel, with a concrete foundation, and will have concrete approaches. The structure will cost about $10,000.

The building permits issued in Stratford, Ont., for the month of June this year numered 49, at a value of $29,593, while for the corresponding period last year there were 29 permits, valued at $26,270.

A permit was recently issued at Vancouver, B. C., to the Canadian Fishing Company for repairs to the cold storage plant on Burrard Inlet, at the foot of Gore Avenue, recently destroyed by fire, to cost $10,000.

During the first half-year of 1915, sixteen permits were taken out at Saskatoon, Sask., the total value of the improvements being $79,070, showing an increase over the corresponding half-year of 1915 of over $70,000.

The Miramichi Hospital at Newcastle, N. B., the gift of Ernest Hutchinson, lumberman of Douglastown, has just been opened. The hospital cost $75,000, is modern in every respect, and has accommodation for fifty patients.

The Montreal Board of Control have devided to insert in all future specifications for tender work a clause by which when a successful bidder declines to carry out the contract, the financial deposit may be retained by the Council.

Claydon Bros., of Winnipeg, have been awarded the contract for the construction of an addition to the sanitarium at Ninette, Man. The contract price of the work is $43,000. Work has been begun and will be rushed to completion.

It is understood that the Monarch Knitting Company, of Dunnville and St. Thomas, will erect a $50,000 factory in the latter city and will employ 200 hands within a year, in return for a $30,000 loan and a fixed assessment for $10,000.

It is understood that the rears of the buildings from the Merchants Bank at the corner of Fifth Street to the Bank of Commerce at the corner of Sixth Street in Chatham, Ont., will be improved in the near future, and that a new cement driveway will be laid behind these structures.

Work began recently on the excavation for the new addition to the Dominion Textile Company's plant at Montmorency Falls, Que. It will be built of reinforced concrete, five storeys high, 245 feet by 45 feet. The cost will be in the neighborhood of $90,000.

In connection with the work on the Ottawa South sewer, the Robinson Avenue part of the work, about 700 feet, is now complete, with pipe laid, and the tunnelling under the G. T. R. and C. P. R. tracks near Hurdman's bridge is to be proceeded with.

It ic announced that the tenders of the Northern Construction Company, of Winnipeg and Vancouver, and the Carter-Halls- Aldinger Company, of Winnipeg, in connection with the erection of the proposed Canadian Northern Depot at Vancouver, have been accepted jointly.

Construction work has been commenced on the new Russell Motor Car Company factory on Eagle Avenue, Weston, Ont. The building will be a two-storey brick structure, 300 feet square, standing on a site of 28 acres. It is expected that it will be completed by October.

Contractors G rantand Horne are making rapid progress with the construction of the McAvity mammoth machine works on the Marsh Road, St. John, N. B. This plant will be ready for the manufacture of munitions and general machinery on August 1. It is the intention to concentrate all the firm's brass and steel plants in the city on the new site.

Extensive damage was caused at Ashcroft, B. C., by a recent fire. The fire started in the Ashcroft Hotel and within three hours spread over the whole business section, reducing it to ruins. Both hotels, the Dominion Government buildings, a dozen stores, bank buildings, and a mass of old wooden buildings composing Chinatown, were burned.

The old buildings on Cliff Street, St. John, N.B., which occupied the site that has been selected for the new Catholic High School for Girls, have been razed to the ground, and work of erecting the new structure has begun. It will have a frontage of 123 feet, and will run back 87 feet, with an extension of 40 feet for gymnasium. The building will be three storeys high, and will be constructed of brick.

It has been again stated that the erection of the big steel plant which the United States Steel Corporation plans to erect at Ojibway, near Windsor, Ont., will be started at once. The company over two years ago secured a large tract of land as a site, but little has been done up to the present. It is understood that the plant to be erected will cost about $25,000,000.

The estate of the late Donald Fraser, a prominent provincial lumberman, has contributed an annex to the Victoria Hospital, Fredericton, N. B., in memory of the deceased. It will cost $60,000. In addition to the memorial hospital, there will be a Fraser Memorial building attached to St. Paul's Presbyterian Church, Fredericton, the cost of which will be about $40,000.

It is stated that Price Bros. & Company, Limited, the big Montreal paper concern, propose to make considerable enlargements to their plant. This will include the erection of a new unit to be added to the news print mill, and additions to other plants which will increase the company's production of sulphite and ground wood pulp. The new paper unit will probably be in operation by February 1, 1917, while it is expected that the other additions will be completed by October of the current year.

Representatives of the International Nickel Company were at St. John, N. B., last week examining possible sites for the nickel refining plant which the company is to erect in Canada. They were pleased with the prospects here and have asked the city council for terms for property it owns on the river front. Before presenting their report to the company the engineers will investigate some other maritime locations.

A new fectory has just been built for the T. Eaton Company in Hamilton, on the corner of John and Gore Streets. Is is 300 ft. x 75 ft. in dimensions and is constructed in the flat-slab reinforced concrete style with brick-veneer outer surfaces trimmed with terra cotta. The present building is four storeys high, but the foundations will support an additional two storeys, when the expansion of the business may so require.

The river route to Westfield from St. John, N.B., will be followed in the completion of the southern end of the Valley Railway. The Nerepis will be crossed by means of

a "fill" and a central bridge span. This crossing will be designed to accommodate both railway and highway traffic. The contract for the Nerepis bridge has been awarded to A. R. C. Clark & Son, contractors and builders, of St. John, who will begin work at once.

Mr. A. F. Macallum, the new commissioner of works at Ottawa, plans an immediate re-organization of the engineering and waterworks departments of the city. One of the first branches to receive his attention will be the accounting branch. Under the system he proposes to establish, it will be possible to ascertain the cost of all work, and of the labor and material entering into it. The engineering staff he thinks is unnecessarily large.

A deputation recently interviewed the Minister of Public Works in regard to the proposed harbor improvements at Port Dover, Ont. The Public Works Department at Ottawa holds plans in this connection and the L. E. & N. Railway have made arrangements for a car ferry service across the lake if terminal facilities can be secured. It is estimated that the amount to be expended for creating the desired wharfage facilities will be about $250,000.

Mr. S. C. Oxton, Deputy Minister of Public Works, Manitoba, announced recently that the work of remodelling the old law court building in Winnipeg will not be let by contract, but will be done under the Department of Public Works and supervised by their own engineers. It is thought it would be impossible to let the work by contract as the job will have to be done one room at a time, and changes in the plans may have to be made from time to time.

The work of building the new public school at Sarnia, Ont., to take the place of the present building on Lochiel Street, is now under way. The excavation work has been completed, and foundation work is progressing. The building will be constructed of red pressed brick with sandstone trimmings, and will have ten teaching rooms, besides private rooms for the teachers. The old school will be left standing until the new structure has been completed.

The Canadian Pacific Railway Company, anticipating an increase of 30 or 40 per cent. in next winter's business through the port of St. John, N. B., are planning a number of improvements for the "Growing time." These improvements include an increase of yardage capacity from 1,500 cars to 1,850 cars, the reclamation of a large area of territory on the west side, the erection of a 20,000 gallon water tank, and the extension of all freight sidings between this port and Montreal. Construction trains are busily engaged in carrying material for the "fills" on the west side.

Rapid progress has been made toward the completion of the Rogers Pass tunnel of the C. P. R. line which is under construction. Up to May 13 the distance completed at the west end of the tunnel was 11,296 feet, and at the east end 12,049 feet, making a total of over four and three-quarter miles. The total length of the tunnel will be 26,400 feet when completed, so that at that date there was only left 3,055 feet to be tunnelled. The new line made by the tunnel will eliminate a long curvature and many snowsheds which are features of the road now in use.

It is expected that the new Dominion Government small-arms ammunition factory at Lindsay, Ont., on which work is now progressing, will be completed in the month of September. One reason to which the choice of Lindsay as the location of the arsenal may be attributed is on account of the large supply of electrical energy which the town has on tap. The site of the plant is one hundred acres of land in the South Ward. The building will be of concrete, steel and glass, and Messrs. Westinghouse, Church & Kerr Company, of New York, in whose hands the contract has been placed, purpose to emply fully four hundred men on its erection and the installation of machinery. It is stated that already millions of dollars have been expended on machinery and that a big rolling mill plant has been purchased in the United States. The numbers of hands to be employed in the factory, it is announced, will be about 2,000.

A report has been prepared regarding the proposed Brandon-Carberry highway, by Engineer Lyon, assistant to Mr. J. A. McGillivray, Highways Commissioner for the Province of Manitoba. From this report it is seen that the cost of this road will be less than $20,000, exclusive of gravel and labor. The gravel, however, can be obtained free at the pits, and it is presumed that alien labor will be used to a great extent. There will be three bridges to be built between Brandon and Sewell and several small culverts. The report also recommends the construction of an overhead bridge over the crossing of the Grand Trunk Pacific at a deep and very dangerous cut.

The work in connection with the power development scheme of the Great Lakes Power Company at Sault Ste. Marie, Ont., is well under way. All the equipment necessary for the preliminary work is on the site and excavation work is being rushed in order that the concrete work on the power house may be well advanced this fall, two steam shovels being used in the operations. The canal site is located 250 feet south of the present power house and extends to beyond the C. P. R. tracks. The new power house will be 270 feet long by 60 feet wide and will be built at the end of the present power house. Reinforced concrete construction will be used throughout. The ground below this will be excavated for the tail race. There will be twelve twin units in this initial development and the total capacity of the plant when it is all developed will be about 20,000 h.p. The ground which is being excavated is being utilized in filling and grading the low spots on the Government lock property and is being removed by standard gauge locomotives and dumping cars. Mr. J. O. Heyworth has the contract for the design and construction of this plant. He maintains both engineering and construction offices on the job. It is thought that the entire work will be completed by January, 1918.

Personal

At a recent meeting of the Quebec city council the resignation of Mr. T. A. Forrester as waterworks engineer was accepted.

It is announced that Major T. C. Irving, Jr., the well-known Toronto civil engineer, who entered military service and went overseas some time ago, has been married in England.

Obituary

Mr. Lorne Marshall died recently at Gravenhurst after a long illness, at the age of 33 years. He was born near Bracebridge and was engaged in the contracting business with his brother in Toronto.

The death is announced of Wm. Northgrave at St. Mary's, Ont. The deceased had been a municipal employee for the past fifteen years and latterly held the position of Road Commissioner. He died at the age of 53 years after a lingering illness.

Mr. Charles H. Osler, civil engineer of the Montreal Light, Heat and Power Company, died suddenly in his office from heart failure recently. Mr. Osler was 56 years of age, and was born in Sheffield, England, coming to Canada when twelve years of age. He commenced his engineering career with the Kingston and Pembroke Railway, after which he went west for the Canadian Pacific Railway as engineer of location for western lines, finally coming to Montreal and joining the Montreal Light, Heat and Power Company.

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Merely Spectacular

THE arrival recently of a German submarine in a United States port is hailed by many as the beginning of a new epoch of maritime development. The feat is undoubtedly notable in the face of a condition of war, but its effect in stimulating permanent undersea traffic seems to us a matter of doubt. The German nation unquestionably lauds the accomplishment because of an apparent frustration of British blockade methods and this initial success will probably lead to further attempts of a similar nature. Probably its most noticeable effect is its reminder to the United States of what might happen if these two nations were at war.

Any importance, indeed, that attaches to this event cannot lie in the fact that a submersible has accomplished such a long journey, because there have previously been as long or longer voyages made by both British and German submarines. The fact, however, that the vessel is purely a merchantman—if reports be true—is important. This fact is valuable from an engineering view-point, in that it probably means a re-cast of submarine design. A vessel of this nature capable of carrying merchandise must necessarily be different from the accepted war type. The capacity, speed, strength and radius of operation, must of necessity be of different character from the same features of the armed submarine. Examination of the "Deutschland" will probably show these special characteristics and the experiences gained in this trip will govern materially the design for further merchant submarines.

Outside of these engineering problems, however, we do not believe that the "Deutschland" can have any important effects. Possibly this venture will lead to others, but they will merely serve to indicate that Germany's economic condition is entirely upset. The very nature of the cargo which this vessel is reported to be carrying back is sufficient in itself to indicate the effectiveness of Britian's blockade. During the war cargo-carrying submersibles may possibly play a part in linking up Germany with the outside world, but how great the risk will be the future only can tell. At any rate it forces upon the diplomats a new problem of naval warfare.

Aside, however, from this more or less empirical theory, unjustified as yet, we feel that insofar as it leads to permanent trade advantages the submarine can never be a success. After the war, undersea traffic will have no object. Its institution now is merely a passing solution for an economic difficulty. As a criterion of the world's development it lacks the earmarks of permanency.

Ship-Building in Canada

WITH the idea of obtaining first-hand information regarding the cost of building steel ships on the Canadian-Atlantic coast, the Nova Scotia Steel & Coal Company have already laid the keel for a ship of 2,000 tons capacity, which, it is expected, will be launched late this autumn. The vessel will be 220 feet long, 35 feet beam and 20 feet deep. It will be built according to Lloyd's specifications and will be equipped with a 1,000 h.p. De Laval steam turbine specially designed for this vessel and geared to the propellor shaft with two sets of gearing. The equipment also includes a rotary air pump and a centrifugal circulating pump operated by a single engine. Practically the whole ship, including the fittings and equipment, will be supplied by the company's New Glasgow plant.

Although the company has not committed itself definitely to a scheme of shipbuilding, they hope that the data collected from the construction of this trial vessel will lead them to build many more. The company will determine whether government aid will be necessary for the promotion of the shipbuilding industry in Canada, and they will study the many factors involved in the operations, especially the labor conditions. Although labor is cheaper in Britain, yet it is felt that the better service secured from workmen in Canada will largely counterbalance this.

New Glasgow as a location for a shipbuilding plant possesses many advantages. There are few places

where so many economies in carrying out the undertaking could be effected. The Nova Scotia Steel & Coal Company already have installed much of the necessary machinery which a new company would have to buy.

Hon. Col. Thos. Cantley, president of the Nova Scotia Steel & Coal Company, has made an intimate study of the shipbuilding situation, and is well qualified to give opinions in this regard. Before a recent convention of the C. M. A. he stated that one thing necessary to stimulate the industry in Canada and thereby to form a Canadian mercantile marine, was government financial assistance. Other maritime nations have found this necessary, and it was not to be expected that Canada could succeed in a similar enterprise unless she is prepared to follow the same methods. He stated that many years would be required to build up an organization of skilled workmen with the necessary experience to enable this country to compete successfully with foreign countries. During this adolescent period government assistance and protection would be required.

The best system, in the opinion of Col. Cantley, was the payment of a bounty of, say, $10 a ton for the construction of steel steamers over 1,000 gross tons, and if these were equipped with machinery of home manufacture $2.50 per indicated horse power should be added to this bounty. This system, which is in vogue in Japan, has increased the merchant marine fleet of that country from 360,695 tons to 1,500,000 tons in the twenty years from 1895 to 1915. Such an arrangement would not be, by any means, permanent, but might apply for a period of between 10 and 15 years until shipbuilding got a firm footing. Canada is quite able to supply the raw material necessary for the construction of steel ships now or within a year, if sufficient encouragement were granted. Mr. Cantley stated that what was necessary for making a shipbuilding project a success was government assistance, co-operation of workmen, good shipping laws and lower insurance rates.

Value of Graduate Courses

A very interesting article appears elsewhere in this issue by Prof. Blanchard, of Columbia University, on the value of graduate, or as we generally term them in Canada, post graduate, courses for practicing engineers. It is pointed out that while engineers may receive very valuable information from magazines, books, engineering societies, and so on, they are certain to find what they want more quickly, and in more concentrated form, in a properly arranged graduate course. No doubt this is true. The graduate course, however, has had an uphill fight on this continent for many reasons, and, indeed, in only a limited number of cases has its value been adequately recognized. In Columbia University, however, where this idea took root early, the results are evidence of the wisdom of a course which other universities have been slower to follow. Professor Blanchard speaks particularly for the department of highways, of which he has charge. The list of graduate courses he outlines looks good to the man who knows the kind of information our highway superintendents and others interested in this work ought to possess. No doubt the lack of fuller information is felt by every good man engaged in highway work in Canada, and no doubt, too, it is this want our government highway departments are trying to fill when they offer information of various sorts to their employees. A splendid example of this is the lecture course inaugurated by the Ontario Highway Department by its head, Mr. W. A. McLean, which for a short term, during the past two years, has assembled Ontario roadway engineers and superintendents for a conference of study and discussion on practical problems. This work of education, however, seems to belong to our universities, and these, apparently, all too often fail us when we want to learn something not found in books. In the matter of practical instruction Canadian universities possibly are lacking. Cannot this side of our education be developed, without sacrificing the others, and, if so, is it not the duty of the university to undertake it?

The Government's New Scheme for Wounded Soldiers in Training

WE Canadians are absolutely unanimous about one thing in this war,—that justice and reparation must be secured for those who have suffered. The men who have volunteered to fight for us, while we have stayed safely at home,—these men, coming back shattered and torn, or with health in any way impaired by their service, must have reparation, and from us.

It is the first word of justice; and there is no Canadian worthy of the name who will not agree to it with all his heart.

Our head as well as our heart, however, must be employed to devise a form of reparation that will really repair—that will as far as possible make up to these men what they have lost.

From the beginning of the war it was recognized that a man offering his body to defend our cause should have compensation for any injury his body might suffer in the carrying out of that task. A scale of pensions was adopted both for disabled soldiers and for their dependants, in proportion to the degree of disability. A revised scale, involving a large increase of expenditure, was lately agreed to by a Parliamentary Committee and is already in force.

A pension alone, however, will not restore the injured man to his place as an active and useful member of the community; and that has got to be done, by some means or other, both in the community's interest and in his own.

A very few of the injured will be found so totally helpless that this restoration is impossible. On the other hand, judging by our experience so far, a large majority, in spite of their injuries, will still be fit for their former work. But between these two classes will be many men with injuries either handicapping them seriously in their old occupations or barring them out altogether.

Such men must not be condemned to perpetual uselessness. They would not thank us for that. They are not of the back-boneless kind, or they would hardly have thrown themselves into the war. They did not enlist to be coddled or spoon-fed, and they will not want to be coddled and spoon-fed now. Having recovered their strength, they will naturally expect to use it. The question simply is—How?

Re-education

To begin with, their disability can often be lessened by what is called "functional re-education." By special exercises, with or without the aid of the ingenious apparatus invented for the purpose, the muscles mutilated by wounds and operations, and weakened by compulsory disuse, can recover some of their

strength and become once more accustomed to exertion. Then, by "vocational re-education," the men can be enabled to return to their original trade; or, when that is impossible or undesirable, they can be helped to fit themselves for another occupation. There is no intention, by the way, to provide re-education for men who do not need it.

The Parliamentary Committee having this matter in charge has decided that the cost not only of pensions and artificial limbs but also of this vocational training, should be paid by the Dominion Government.

The Military Hospitals and Convalescent Homes Commission, with Sir James Lougheed at its head, has already given a great deal of consideration to the matter, and has taken steps to organize the training required in many parts of the country. The complete establishment of the system may be expected very soon;for the Government, by Order-in-Council, has just adopted a report of the Military Hospitals Commission, of which we are enabled to give this summary:—

Interim Report

The report begins by explaining that the Commission aims at benefiting not only disabled members of the Canadian Expeditionary Force, but also disabled Reservists of the British and Allied armies who were bona fide residents of Canada when the war broke out.

The Commission has received the assurance, it tells us, of the active co-operation of the Provinces and various Municipalities in carrying out such a policy. Technical schools, agricultural colleges and other public institutions have agreed to receive disabled men for training, and many offers have also been received from private commercial establishments to provide training and subsequent employment when the men have become proficient.

The period of training for a new vocation will vary according to the previous education and industrial history of each individual. The cost of tuition will vary in consequence, and also owing to the fact that in many cases the tuition will be free or the fees nominal. (The training will be free to the men in all cases. If there is any charge, it will be paid by the Dominion Government).

The Commission has already undertaken the provision of training in general subjects and elementary vocational work for all men under treatment in the various hospitals and convalescent homes operated by the Commission, irrespective of whether or not such men will later be subjects for vocational training, leading to new occupations. In a few cases, arrangements have also been made for that special training.

The Commission was not able, however, to put into operation a general scheme of vocational training until a scale of maintenance could be arranged for the men undergoing the training and for their dependants. The Commission has therefore prepared a scale under which a small sum for personal expenses will be granted to the men undergoing training, while provision on a sliding scale is made for married men and their dependants, and for those unmarried men who may have persons legally dependent upon them.

Here is the scale which the Commission has now been empowered to establish. It will be understood throughout that "maximum age" means 16 for a son and 17 for a daughter:—

Scale of Payments

1. A single man, with pension, living in, receives free maintenance; that is, board, lodging and washing.

2. A single man, with pension, living out—60c a day.

3. A married man, with pension, living in—free maintenance and $8 a month, with the following additions:—

For wife having no children, $35 a month, less her husband's pension.

For wife and one child, if child is under five, $38; from five to ten years, $39.50; from 10 to maximum age, $42.50; less, in every case, the amount of husband's pension and children's allowances under the pension regulations.

For wife and two children, from $41 to $47 a month (less pension and allowances) according to age of children.

For wife and three children—$44 to $50 (less pension and allowances), according to ages.

For wife and four children—$47 to $53 (less pension and allowances), according to ages.

For wife and five children—$50 to $55 (less pension and allowances) according to ages.

For wife and six children—$53 to $55 (less pension and allowances), according to ages.

A wife with seven or more children under the maximum age may be given the maximum allowance of $55, less pension and allowances.

All these allowances for wife and children will be paid direct to the wife, unless otherwise thought fit by the commission.

4. A married man living at home will receive 60c. a day. (This, of course, is in addition to the allowances for wife and children).

5. A widowed mother, if dependent entirely upon the unmarried son who is receiving training, and if the son made an assignment of his pay to his mother and also arranged for her to receive separation allowance while has was on service, may be paid at the same rate as the wife of a married man with no children.

6. The parents of a man undergoing training, if both are old and past work, and entirely or partially dependent upon him, may also be paid at that rate.

7. The guardian of a widower's children (under the maximum age) will be paid monthly:—for one child, $10; for two, $17.50; for three, $22; and $3 for each child in excess of three, with a maximum of $35.

Payments under these regulations will be continued for one month after the completion of vocational training, whether the man has secured employment or not.

It is clear that this system of allowances will enable many men to take advantage of the training offered, by providing for their families while the training is being given.

The President of the Military Hospitals Commission asks us to say that any further information desired by our readers will be gladly given on application to the Secretary, at 22 Victoria Street, Ottawa.

B. C. Branch Civic Improvement League

Mr. Thomas Adams, town planning adviser to the Commission of Conservation, has been in the Province of British Columbia speaking at various cities on the question of town planning. At Vancouver he addressed a large assembly of delegates representative of the various civic departments and committees and the important associations and clubs, commercial, scientific, social, etc. Delegates from New Westminster, South Vancouver, North Vancouver and West Vancouver, were also present. This meeting was the first session in connection with the formation of a branch of the Civic Improvement League of Canada. Mr. Adams also visited Victoria, where he addressed a meeting of the Board of Trade.

Graduate Courses for Engineers*

The Most Effective Means for Practicing Engineers to Secure Advanced Knowledge — Success of the Highway Department at Columbia University

The practicing engineer may secure advanced knowledge pertaining to modern practice in his specialty by the utilization of one or more of the following agencies: (a) technical literature; (b) meetings and transactions of technical societies; (c) graduate engineering courses in technical institutions.

In technical periodicals may be found innumerable articles pertaining to any one of the several fields of engineering. This literature is distributed through many publications. For example, the Davis Library of Highway Engineering at Columbia University subscribes to eighty periodicals which contain articles on highway engineering or closely allied subjects. The experienced highway engineer finds in this immense amount of literature many articles of value. As a medium for the average engineer to secure a knowledge of fundamental principles and reliable information pertaining to modern highway engineering, technical literature, as found in both books and periodicals, proves unsatisfactory unless his reading is directed by an expert.

Men interested in engineering work will, in most cases, receive valuable inspiration and information from attendance at meetings and a perusal of the literature of engineering societies. The interchange of opinions and experience connected with the many problems of engineering, which is accomplished through the medium of such conferences, is of inestimable value. As a source of training in fundamentals and the acquisition of comprehensive advanced knowledge in the several branches of engineering, it is not usually successful.

Courses Open to Engineers

American educational institutions offer the following channels which are open to men who desire to equip themselves for the profession of engineering.

(1) A Bachelor of Arts, Bachelor of Philosophy, or Bachelor of Science collegiate course with electives in engineering.

(2) A four-year course in general engineering.

(3) A four-year course in a special field of engineering.

(4) A graduate engineering course requiring a baccalaureate degree and a total attendance in educational institutions of from five to six years.

(5) Graduate engineering courses after having followed out one of the educational lines outlined above.

By a judicious utilization of educational facilities, the acquisition of an educational training for any given branch of the engineering profession may be attained by several combinations of the courses previously mentioned. For example, it is evident that a man may pursue a four-year general engineering course devoting one-third time to the humanities, one-third to pure science, and one-third to the fundamentals of engineering. A graduate in such a course, if he desires to fit himself to occupy technical positions of responsibility in a given field of engineering, should, after a few years of practical experience, take advanced engineering courses especially designed for practicing engineers in his chosen specialty. The limits of this paper do not permit of a discussion of the relative advantages of all the methods of preparation for an engineering career.

As used in this paper, graduate courses for practicing engineers refer to advanced specialized courses designed primarily for men who have taken a first degree in art, science, or engineering, who have acquired a knowledge of fundamental principles upon which such advanced courses are based, and who have had a certain amount of practical experience in engineering work.

Those Interested in Graduate Courses

Based on an experience with graduate courses for practicing engineers extending over a period of five years, it has been found that the following classes of men are interested in such courses: (a) graduates of four-year Bachelor of Science courses in general engineering and graduates in non-technical courses who wish to equip themselves for a special field of engineering work; (b) graduates in civil, chemical, electrical, mechanical, and mining engineering courses who come in contact with problems or fields of work with reference to which they desire detailed information based on modern engineering experience; (c) non-graduates who may be engineers, chemists, contractors, manufacturers, or others interested in some special branch of engineering and who have acquired a sufficient knowledge of the fundamental principles to enable them to carry on advanced work satisfactorily. As a definite indication of the demand for advanced courses in special fields of engineering will be cited the fact that during the past five years there have been 220 registrations in the graduate courses in highway engineering at Columbia University.

Effectiveness of Graduate Courses

The conclusion has been reached by experienced engineers that, if graduate courses are to satisfactorily meet the demands of the profession, the following conditions should be fulfilled:

First, the courses must be given by specialists who are acknowledged experts.

Second, the courses must be given under such conditions that it will be practicable for practicing engineers and others engaged in engineering work to take advantage of the opportunities offered.

Third, the graduate work must be broadly administered so that the courses of instruction are open to any mature man provided he can satisfy the prerequisites for the given course or courses which he desires to take.

Fourth, the content of the courses must cover detailed information pertaining to the most recent developments of modern practice.

Fifth, the methods of presentation of the subject

* Presented before the Society for the Promotion of Engineering Education at the University of Virginia Convention on June 20th, 1916, by Arthur H. Blanchard, M.Am.S.C.E., Professor in charge of the Graduate Course in Highway Engineering at Columbia University, and Consulting Engineer, New York City.

matter of the course must be adaptable to the class of men enrolled.

Sixth, ample facilities must be available for conducting research work in laboratories, libraries and in the field, where every phase of the special field of engineering covered by the graduate courses may be investigated.

As an example of a plan which has worked out satisfactorily in supplying the demand for graduate courses for practicing engineers, certain details and facts in connection with the Graduate Course in Highway Engineering at Columbia will be given. The objects in view in founding this course were to elevate the profession of highway engineering in America to the plane of the National Department of Roads and Bridges of France and to provide an opportunity for men engaged in highway work to obtain advanced instruction and training under favorable conditions. The heads of national, state, county and municipal highway departments should be broadly educated, thoroughly trained and experienced specialists in highway engineering and efficient executives. They should be able to publicly discuss and economically solve the fundamental problems of economics, administration, construction and maintenance. Such men should have a broad educational training in such humanities as English, history, economics, philosophy, political and social science. They should also be well grounded in the fundamentals of pure and applied science which underlie highway engineering and the several branches of civil engineering which are utilized in highway work. After a man has secured his fundamental education in engineering and has had a certain amount of practical experience in highway work, the opportune time has arrived for securing professional equipment through the medium of graduate courses in highway engineering.

Favorable Arrangements

For many reasons it is fortunate that the first course of this character was established at a university presided over by a president and trustees who look upon the work of the university from an exceptionally liberal standpoint. While maintaining the high character of all degrees conferred, these men believe in opening the courses of instruction to any mature man provided he has the prerequisites for any given course and earnestly seeks information. Likewise, it is fortunate that the administrative authorities allowed the introduction of an innovation as far as the period of attendance is concerned. The arrangement of the graduate work so that the several courses can be taken by engineers, chemists, highway officials and others desirous of securing advanced instruction in highway engineering under favorable conditions has been fulfilled by, first, giving all graduate courses in the period when it is practicable to secure leaves of absence, namely, from December 1st to April 1st, and, second, by giving each course in a period of from two to three weeks in duration. This latter arrangement enables men who are particularly interested in certain groups of subjects or who are not able to be in attendance for the entire winter session to take any course or group of courses, the prerequisites for which they are able to present.

Scope of the Course

The following statement gives a comprehensive idea of the scope of the Graduate Course and the periods in which the several courses were given during the 1915-1916 session.

Highway Engineering 101—Economics and Design of Roads and Pavements. February 23 to March 8.

Highway Engineering 102—Broken Stone, Gravel and Other Roads; Brick, Stone Block, Wood Block, and Cement-Concrete Pavements. February 9 to February 21.

Highway Engineering 103—Bituminous Surfaces and Bituminous Pavements. January 7 to January 25.

Highway Engineering 104—Highway Jurisprudence, Highway Laws and Systems of Administration. February 23 to March 8.

Highway Engineering 105—Highway Bridges and Culverts. December 1 to December 21.

Highway Engineering 106—Management Engineering. December 1 to December 21.

Highway Engineering 107—Mechanical Appliances Used in Highway Engineering. January 7 to January 25.

Highway Engineering 108—Non-Bituminous Road Materials. Laboratory Course. January 7 to January 25.

Highway Engineering 109—Planning of Roads and Road Systems. March 9 to March 22.

Highway Engineering 110—Planning of Streets and Street Systems. December 22 to January 6.

Highway Engineering 111—Seminar in Highway Engineering Literature. First Session. December to March inclusive.

Highway Engineering 112—Seminar in Highway Engineering Literature. Second Session. December to March inclusive.

Chemistry H199—Mining, Manufacture, Testing and Inspection of Bituminous Materials. December 22 to January 6.

Chemistry H200—Testing of Bituminous Materials. Laboratory Course. January 26 to February 8.

Geology H215—Engineering Geology. January 26 to February 8.

Geology H216—Engineering Petrography. March 9 to March 22.

Requirements for Degrees

As far as amount and character of educational work are concerned, the sixteen courses, which have been previously described, fulfil the requirements for the degree of Master of Science at Columbia University. The University also requires that each candidate for the Master's Degree shall be in residence for one collegiate year or eight months. Candidates for the Master's Degree in the Graduate Course in Highway Engineering fulfil the requirement in one of three ways: first, by being in residence for one collegiate year or from October to May inclusive; second, by being in residence for two winter periods from December to March inclusive; and, third, by the distribution of residence over several years by being in attendance for parts of three or more winter periods. The university further requires that each candidate for a higher degree must hold a baccalaureate or engineering degree from an approved institution.

Representative Registration

In considering the development of the graduate course, it is of interest to note the details of the records for registration for the 1915-1916 session.

Twenty-seven American universities were represented by their graduates. The fifty men registered as Graduate Students were connected with the following fields of work:

State highway departments	8
County highway departments	5
Municipal highway departments	15
Consulting engineers' offices	6
Contractors' engineering organizations	11
University faculties	1
Engineering departments of companies manufacturing road and paving machinery	3
Engineering, research and chemical departments of companies manufacturing road and paving materials	1

Widespread Interest

The widespread interest in the graduate course is shown by the following resume of the localities from which the graduate students came at the time of their registration for the 1915-1916 session: Denmark, New Zealand, Uruguay, Canada, Oklahoma, Connecticut, Massachusetts, New Jersey, Pennsylvania, New York, North Carolina, Texas, Oregon, Maine, Georgia, Louisiana, and Nebraska. It is of interest, as giving indication of the character and maturity of the graduate students, to note that the ages of the men varied from twenty-two to forty-five years and that several of them, at the time of entrance upon the graduate course, were receiving salaries of $3,000 to $5,000.

It is believed that a demand for graduate courses for practicing engineers exists and that the results secured by the establishment of the Graduate Course in Highway Engineering at Columbia University may be duplicated in all branches of engineering and applied science.

Economic Conference of the Allies

Trade Measures Planned for the Period of the War and After—Mutual Assistance and Collaboration Among the Entente Nations

The British Board of Trade issued on June 20th the following full text of the recommendations of the Economic Conference of the Allies recently held in Paris:

I.—The representatives of the Allied Governments have met at Paris under the presidency of M. Clementel, Minister of Commerce, on June 14th, 15th, 16th, and 17th, 1916, for the purpose of fulfilling the mandate given to them by the Paris Conference of March 28th, 1916, of giving practical expression to their solidarity of views and interests, and of proposing to their respective governments the appropriate measures for realizing this solidarity.

II.—They declare that after forcing upon them the military contest in spite of all their efforts to avoid the conflict, the Empires of Central Europe are today preparing, in concert with their allies, for a contest on the economic plane, which will not only survive the re-establishment of peace, but will at that moment attain its full scope and intensity.

III.—They cannot therefore conceal from themselves that the agreements which are being prepared for this purpose between their enemies have the obvious object of establishing the domination of the latter over the production and the markets of the whole world and of imposing on other countries an intolerable yoke.

In face of so grave a peril the Representatives of the Allied Governments consider that it has become their duty, on grounds of necessary and legitimate defence, to adopt and realize from now onward all the measures requisite on the one hand to secure for themselves and for the whole of the markets of neutral countries full economic independence and respect for sound commercial practice, and on the other hand to facilitate the organization on a permanent basis of their economic alliance.

For this purpose the Representatives of the Allied Governments have decided to submit for the approval of those Governments the following resolutions:—

A.

Measures for the War Period

I.—The laws and regulations prohibiting trading with the enemy shall be brought into accord.

For this purpose:—

A.—The Allies will prohibit their own subjects and citizens and all persons residing in their territories from carrying on any trade with:—

1. The inhabitants of enemy countries whatever their nationality.
2. Enemy subjects wherever resident.
3. Persons, firms and companies whose business is controlled wholly or partially by enemy subjects or is subject to enemy influence and whose names are included in a special list.

B.—They will prohibit the importation into their territories of all goods originating in or coming from enemy countries.

C.—They will devise means of establishing a system enabling contracts entered into with enemy subjects and injurious to national interests to be cancelled unconditionally.

II.—Business undertakings owned or operated by enemy subjects in the territories of the Allies will all be sequestrated or placed under control; measures will be taken for the purpose of winding up some of these undertakings and of realizing their assets, the proceeds of such realization remaining sequestrated or under control.

III.—In addition to the export prohibitions which are necessitated by the internal situation of each of the allied countries, the Allies will complete the measures already taken for the restriction of enemy supplies, both in the Mother Countries and in the Dominions, Colonies and Protectorates:—

1. By unifying the lists of contraband and of export prohibition, and particularly by prohibiting the export of all commodities declared absolute or conditional contraband;

2. By making the grant of licences for export to neutral countries from which export to enemy territories might take place conditional upon the existence in such countries of control organizations approved by the Allies; or, in the absence of such organizations,

upon special guarantees such as the limitation of the quantities exported, supervision by Allied consular officers, etc.

B.

Transitory Measures for the Period of Commercial, Industrial, Agricultural, and Maritime Reconstruction of the Allied Countries

I.—The Allies declare their common determination to ensure the re-establishment of the countries suffering from acts of destruction, spoilation, and unjust requisition, and decide to join in devising means to secure the restoration to those countries, as a prior claim, of their raw materials, industrial and agricultural plant, stock and mercantile fleet, or to assist them to re-equip themselves in these respects.

II.—Whereas the war has put an end to all the treaties of commerce between the Allies and the enemy powers, and whereas it is of essential importance that, during the period of economic reconstruction which will follow the cessation of hostilities, the liberty of none of the Allies should be hampered by any claim put forward by Enemy Powers to most-favored-nation treatment, the Allies agree that the benefit of this treatment shall not be granted to those powers during a number of years to be fixed by mutual agreement among themselves.

During this number of years the Allies undertake to assure to each other so far as possible compensatory outlets for trade in case consequences detrimental to their commerce result from the application of the undertaking referred to in the preceding paragraph.

III.—The Allies declare themselves agreed to conserve for the allied countries, before all others, their natural resources during the whole period of commercial, industrial, agricultural, and maritime reconstruction, and for this purpose they undertake to establish special arrangements to facilitate the interchange of these resources.

IV.—In order to defend their commerce, their industry, their agriculture, and their navigation against economic aggression resulting from dumping or any other mode of unfair competition the Allies decide to fix by agreement a period of time during which the commerce of the enemy powers shall be submitted to special treatment and the goods originating in their countries shall be subjected either to prohibitions or to a special regime of an effective character.

The Allies will determine by agreement through diplomatic channels the special conditions to be imposed during the above-mentioned period on the ships of the enemy powers.

V.—The Allies will devise the measures to be taken jointly or severally for preventing enemy subjects from exercising, in their territories, certain industries or professions which concern national defence or economic independence.

C.

Permanent Measures of Mutual Assistance and Collaboration Among the Allies

I.—The Allies decide to take the necessary steps without delay to render themselves independent of the enemy countries in so far as regards the raw materials and manufactured articles essential to the normal development of their economic activities.

These measures should be directed to assuring the independence of the Allies not only so far as concerns their sources of supply, but also as regards their financial, commercial, and maritime organization.

The Allies will adopt such measures as may seem to them most suitable for the carrying out of this resolution, according to the nature of the commodities and having regard to the principles which govern their economic policy.

They may, for example, have recourse either to enterprises subsidized, directed or controlled by the governments themselves, or to the grant of financial assistance for the encouragement of scientific and technical research and the development of national industries and resources; to customs duties or prohibitions of a temporary or permanent character; or to a combination of these different methods.

Whatever may be the methods adopted, the object aimed at by the Allies is to increase production within their territories as a whole to a sufficient extent to enable them to maintain and develop their economic position and independence in relation to enemy countries.

II.—In order to permit the interchange of their products, the Allies undertake to adopt measures for facilitating their mutual trade relations, both by the establishment of direct and rapid land and sea transport services at low rates, and by the extension and improvement of postal, telegraphic, and other communications.

III.—The Allies undertake to convene a meeting of technical delegates to draw up measures for the assimilation, so far as may be possible, of their laws governing patents, indications of origin, and trade marks.

In regard to patents, trade marks, and literary and artistic copyright which have come into existence during the war in enemy countries, the Allies will adopt, so far as possible, an identical procedure, to be applied as soon as hostilities cease.

This procedure will be elaborated by the technical delegates of the Allies.

D.

Whereas for the purposes of their common defence against the enemy the Allied Powers have agreed to adopt a common economic policy, on the lines laid down in the Resolutions which have been passed, and whereas it is recognized that the effectiveness of this policy depends absolutely upon these Resolutions being put into operation forthwith, the Representatives of the Allied Governments undertake to recommend their respective governments to take without delay all the measures, whether temporary or permanent, requisite for giving full and complete effect to this policy forthwith, and to communicate to each other the decisions arrived at to attain that object.

Foundrymen's Convention at Cleveland

The annual convention of the American Foundrymen's Association and the American Institute of Metals will be held during the week of September 11 at the Hotel Statler, Cleveland, Ohio. In conjunction with the convention there will be an exhibition of foundry equipment and accessory machinery, machine tools, etc., in the Coliseum. Present conditions seem to indicate that both the convention and exhibition will surpass any similar undertaking. It seems that an annex will be required to house many of the exhibits. This industrial exhibit will be one of the biggest and most complete shows of its kind ever held. At the meetings of the convention there is promise of an unusually valuable and interesting programme. The papers and reports that have been planned cover an unusually large and interesting field in regard to foundry practice.

Toronto Union Station in progress of construction—Looking east from York St.

Work on New Union Station, Toronto, Well Under Way

The accompanying illustrations show the progress that has been made on the new Toronto Union Station. The construction work was started during the winter when excavations for the foundations were made. The concrete piers rest on bed rock at a depth of about 30 feet. The concrete work is now complete and excavation is being carried on for the sub-basements, including machine, furnace and boiler rooms. Considerable difficulty has been encountered with water oozing in on account of the work being below lake level. The rains some time ago hindered operations to a large extent also, but excavations were kept dry by the use of pumps and syphons.

Steel work is progressing on the east and west wings, the first floor being complete and the second started. The delivery of steel is at present uncertain and in consequence advancement is rather slow. As soon as this is overcome constructional work is expected to be more rapid. A lack of labor also hinders to a great extent any very fast progress. The methods employed on the foundation work and the steel erection have been in no way remarkable, standard and

Toronto Union Station in progress of construction—looking west from Bay St.

Toronto Union Station as it will appear when completed.

accepted methods having been so far applied. The derricks seen in the illustration are said to be among the largest in use.

One cut herewith shows the architect's perspective of the station as it will appear when finished. It will occupy a whole block from Bay Street to York Street, about 850 feet, facing on Front Street. The other photos show recent construction views.

P. Lyall & Sons are the general contractors on the work. The dimension stone is being supplied by Geo. Oakley & Son, Toronto, and will be obtained from the Indiana, U.S.A., quarries. Some of the piers will contain the largest stones ever set up in Canada. The architects associated with the planning of the building are Ross & Macdonald, Hugh C. Jones and John M. Lyle.

A New British Trade Association

THE organization of the United British Industrial Association, now in process of formation, is a most important movement along industrial lines. The association already includes in its membership 50 leading industrial concerns of Great Britain, having an aggregate capital of $250,000,000. It is aiming at a membership of 100, and since the entrance fee is $5,000, it will start its campaign with a fund of $500,000. The objects of the association are stated to be four-fold:

First: The association is to deal appropriately with both political and commercial questions as far as they may affect industry and trade, feeling that foreign control of raw materials is as serious a danger to British industry as foreign attempts to capture our markets at home and abroad.

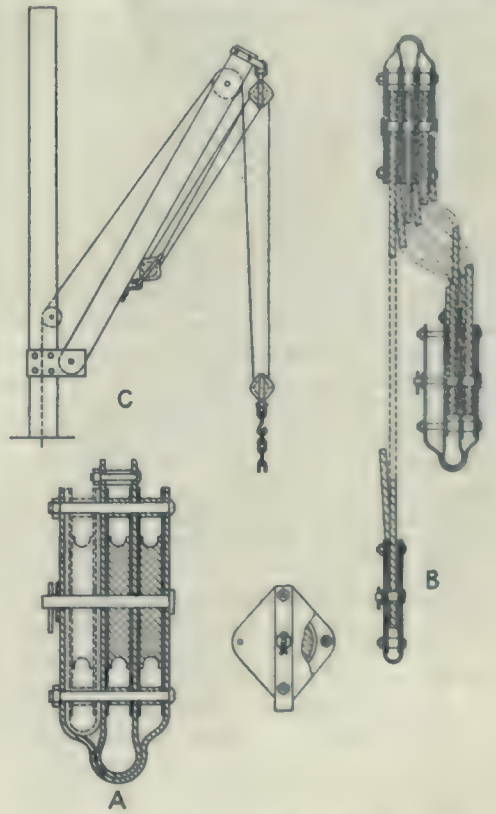
Second: To represent the business man when the government is framing industrial legislation and to be consulted by it in the same way as trade unions are at present.

Third: To deal with labor on comprehensive lines in order that better understanding and co-operation may be brought about between employers and labor.

Fourth: To organize British trade interests in foreign and colonial markets.

Converting a Several-Part Fall to a Two-Part Fall

It is often desired to use a derrick for both heavy and light loads. For heavy loads a five or six-part fall block is frequently required, but for light loads this is too slow to be economical. Unreaving the line and replacing the block with one of less fall is tedious. To overcome this, the block shown in the illustration,



shown in a recent issue of Engineering and Contracting, was devised, which allows the change to be made in a few minutes without unreaving the line. The compound block has one pulley made removable, as shown by the dotted line, which when taken out is a complete single pulley block. To change the derrick, this pulley is removed and the remainder of the block is hooked to the boom.

Variability of the Strength of Concrete

Concrete not a homogeneous product—Its properties depend on a number of constantly changing conditions—Tests conducted by U.S. Bureau of Standards

CONCRETE is not manufactured in general in such a way as to insure a perfectly homogeneous product. It is not made under rigid inspection or under the supervision of skilled specialists. In this way it differs from many other structural materials, such as steel, of which the characteristics are well defined. The quality of structural steel is a constant quantity which can be easily and readily determined at the rolling mill. The strength of a fabricated structure can be determined beforehand by calculation along defined lines. During construction, the physical properties of steel undergo no change provided the design and construction has been carried out along the lines of standard practice. So constant are the properties and so homogeneous is the product that the strength and capacity of any structure can be readily and correctly determined before erection.

With concrete, on the other hand, a large number of variable quantities must be taken into consideration. The proportions of the ingredients, the skill of the labor required, the manner of placing, the time of setting, the thoroughness of mixing, temperature and humidity, exposure to weather conditions—all these, with other factors, have a governing influence in the final quality of the product. Furthermore, the materials employed in the formation of concrete are obtained from so many different sources and differ so widely in characteristics that the quality of the concrete is greatly affected.

Cement is Standardized

Cement, alone, is the only material entering into the fabrication of concrete, which is usually subjected to test. The manufacture and properties of Portland cement have been made the subject of careful study by engineering bodies, the results of which are incorporated in the standard specifications of the American Society for Testing Materials. These specifications furnish a reliable guide for the quality of cement, so that this material may be regarded as well-defined in its properties. But cement is only one item entering into concrete, and the strength of a concrete structure can be no more completely determined by a knowledge and inspection of the properties of cement than can the strength of structural steel be measured by an analysis of the iron ore from which the steel is to be made.

Concretes made with standard quality cements may differ very widely in strength, depending on the aggregates used; also, with the same cements and aggregates, different workmanship in fabrication may adect the strength by several hundred per cent. Again, if concrete is allowed to dry permanently from the time of mixing, it will never attain the strength of one of similar proportions which has been supplied with water occasionally after mixing. There are, besides these, other variables, some of which are enumerated above, that will cause the strength of concrete to vary within very wide limits, but one of the most important is the quality of the aggregate material.

Requirements of an Aggregate

A suitable concrete aggregate should possess principally cleanliness, strength, homogeneity of structure, and proper gradation of particles. The relative values of these variables are difficult to determine and may differ in any two cases.

The coarse aggregates usually employed are granites, trap rocks, gravels, limestones, sandstones, slag, and coal cinders. The physical properties of these materials, such as strength, hardness, porosity and gradation of size of particles, differ very widely. In any one of the materials alone, the range in qualities is often as great as between any two of the materials. Cinders are possibly an exception. Granite is generally conceded to be superior to limestone as an aggregate, but so great is the variation of properties found in granites that some limestones are superior to many granites. Limestone is often favored to a gravel in specifications because it is believed that the sharp angular corners of crushed limestone aid in the formation of a stronger concrete. Although sharpness and angularity may contribute to the strength of a green cement, yet after a few weeks' ageing, the adhesion between the stone and cement becomes sufficient to counteract this effect. The roundness of gravel aggregate has advantages in flowing into place more readily and producing in this way a denser mixture with less spading and tamping. Granite, as before stated, is considered superior to limestone, but if the two are available, actual tests are desirable because the range in properties is so great.

In designing a concrete structure, knowledge of the compressive strength within reasonable limits is necessary, because the working loads are based on an assumed strength value, using a factor of safety to take care of all variations in workmanship and uniformity of material, and to provide for any occasional excessive loading. The factor of safety cannot be depended upon to provide for the differences in strength devolving upon the use of different aggregates even if workmanship be of the best. Hence, the selection of the aggregate must be carefully exercised. Experience to a large extent demonstrates the suitability of available aggregate materials in most localities, but untried materials should always be tested before use in structures of any importance.

The necessity is emphasized of having a knowledge of all of the materials entering into the formation of concrete, and of exercising extreme care in every phase of the manufacture, if the good quality of the product is to be assured and one of known quality produced.

With the object of obtaining exact data in this regard, the United States Bureau of Standards have been conducting experiments to observe the strength and other properties of concrete as affected by materials and methods of preparation, the results of which are incorporated in one of the Bureau's recent technologic papers. In these tests all the variables above noted were changed in various combinations and the compressive strengths of the resulting concretes were measured. In the following paragraphs some salient features of the tests are given.

Type of Aggregate

In testing concrete as affected by the type of aggregate it was found that at the end of four weeks the range of compressive strength in pounds per square

inch was as follows:—the limestone, 1,276 to 3,984, range of 213 per cent.; granite, 2,376 to 3,054, range of 29 per cent.; gravel, 888 to 4,126, range of 354 per cent.

Many of the values obtained with the limestone exceeded the highest value obtained with granite, but the average is greatly reduced on account of many low testing limestones being included. With very few exceptions there is a gradual increase in strength with age. The results show that there is as great variation in the strength of aggregates of the same type as between aggregates of different types, and it cannot be said in general that any particular type is superior to all aggregates of any other type.

All results seem to indicate that the type of aggregate is no guarantee of strength in concrete, even though strength were alone due to the material used, but that qualities, such as hardness, shearing strength and gradation of particles, are all even more important. The range of qualities in any of these types is very great and the strengths of concretes made up of several different materials of the same type may vary as much as several hundred per cent. with all other controllable factors uniform.

Workmanship

To determine the effect of workmanship, samples of concrete were fabricated by different construction companies using different methods of mixing, and the results show that the greatest variation in strength is due to the use of varying quantities of water, but using practically the same quantity of water and all other conditions being the same except the actual method of mixing, variations of as much as 70 per cent. in compressive strength are obtained.

Undoubtedly greater uniformity is generally obtained by machine mixing than by hand mixing. The method of mixing is of little importance so long as it results in a homogeneous mass. Using proper methods and with the expenditure of sufficient labor, results indicate that as good concrete can be obtained by hand mixing as by machine mixing, although it probably would not be economical.

Method of Laying

Experiments show that in concrete laid under water there is a considerable reduction in its strength. The chief problem is to keep the surrounding water from segregating the materials while the concrete is deposited.

Effect of Water

The strength of concrete is very materially affected by the quantity of water used in mixing the concrete. It was found that in the case of limestone concrete the maximum strength was obtained with 8 per cent. of water and in gravel concrete, with 6 per cent. of water. In the case of limestone concrete it was found that 3 per cent. excess over the amount required for a maximum strength caused a reduction in strength of over 50 per cent., while the use of 3 per cent. less than the maximum caused a reduction of about 33 per cent. An excessive amount of water has even a more marked effect when gravel is used as an aggregate.

During the past few years it has become the practice on large concrete construction jobs to mix the concrete at a central point and convey the mixture to the various parts of the structure by means of a tower and chutes. That this method has proven very economical for the contractor is shown by its almost universal use on large work; but the quality of the concrete in place has apparently been a secondary consideration. It is possible that good quality concrete is obtained when the materials are handled in this manner, but it is probable that the strength obtained is very much less than what it should be for the same materials properly mixed to a drier consistency. Throughout all the tests where "fluid" and "mushy" or "quaking" consistencies are used the "mushy" or "quaking" consistencies invariably give the greater strength. The consistency of the concrete normally used in spouting is usually much wetter than any used in the test .

Another fault of the fluid or watery consistency is its tendency to segregate when placed in the form. The heavy aggregate settles just below the chute or spout, and the soupy mixture of cement and fine sand or dirt, if the aggregate be at all dirty, flows to the outer face and corners of the form. It is this segregation which undoubtedly accounts for the crazing and cracking of the surface of many retaining walls and other similar structures.

In the field there is often formed in concrete structures which are made of watery mixtures a layer of relatively inert fine material, which floats on the surface as the concrete is deposited and is usually left in place between day's work, forming a weak horizontal layer or seam in the wall. This weak layer, if at the top of the wall, is often referred to as "laitance." It may be from a fraction of an inch to several inches in thicknes . If the wall is exposed to the weather, this weak section may be cracked and eroded, as is often observed in retaining walls and arches. This is particularly apparent if the structure is exposed to seepage water. Much of this trouble can be obviated by the use of drier mixtures.

Too much emphasis can not be placed on the objection to using an excess of water in mixing concrete.

The most satisfactory consistencies for concrete, from the standpoint of strength and durability, are the quaking and mushy mixtures and the error should be on the side of using too little rather than too much water, providing the concrete is properly spaded or worked into place in the forms.

This statement does not apply to the very dry mixture used in the manufacture of concrete blocks, etc. In the case of these products the mixture should contain the maximum quantity of water which will permit of the immediate removal of the molds. This latter mixture has less water than the quaking consistency described above.

Density

With the same aggregates and the same proportion of cement to total volume of aggregate the mixture having the greatest density will have a high and usually the highest compressive strength.

Density is no criterion of compressive strength of two mixtures of an aggregate if the ratio of cement to total volume of aggregate is not the same.

Density is no criterion of compressive strength of two mixtures of the same proportions of cement to total aggregate if different aggregates are used, although when the aggregate are quite similar they may be comparable.

Exposure

The character of the exposure of the concrete after molding materially affects its compressive strength. If the original water is permitted to evaporate from the concrete and all water is subsequently excluded, the compressive strength may be reduced 40 per cent. or more. Concrete should preferably be kept wet

for several days or weeks after it is deposited if the maximum strength is to be attained.

Abnormal Methods of Curing

The results of tests in this regard are of especial interest to manufacturers in the concrete-products industry, such as tile and block makers. In these industries the amount of floor and storage space can be greatly reduced by shortening the necessary time of curing. Briefly, the results show that up to 80 pounds per square inch gauge pressure steam has an accelerating action on the hardening of Portland cement mortar and that the compressive strength increases with the steam pressure as well as with the time of exposure to steam. A compressive strength considerably (in some cases over 100 per cent.) in excess of that obtained normally after ageing for six weeks may be obtained in two days by using steam under pressure for curing. Furthermore, the steam permanently accelerates the hardening of the concrete which subsequently increases in compressive strength with age upon exposure to the atmosphere. The tests above quoted, along with others which have been made, lead to the following conclusion in addition to the facts noted above:

The steam-cured mortar or concrete is of much more uniform appearance and is made lighter in color than normally aged mortar or concrete made from the same materials.

The mortar or concrete should obtain an initial set before it is exposed to the steam treatment.

For steam curing a "plastic" or "quaking" consistency is preferable to a very dry or very wet consistency.

The initial modulus of elasticity and yield point appear to increase directly with the steam pressure.

The compressive strength obtained by steam curing is directly proportional to the cement content of the mortar.

Gradation of Aggregate

There is no definite relation between the gradation of the aggregate and the compressive strength which is applicable to any considerable number of different aggregates.

Maximum density and maximum strength are usually obtained with a concrete in which the ratio of fine to coarse aggregate is not less than 1 to 3. This mixture is usually quite stiff and therefore more difficult to handle than a mixture containing a larger percentage of fine aggregate.

Excessive fineness does not necessarily result in a totally unsatisfactory sand for concrete. A seashore sand having 99 per cent. passing a 50-mesh sieve, when mixed with a good coarse aggregate and cement, was found to give a satisfactory concrete.

Relative Proportions

With the relative volume of fine and coarse aggregates fixed, the compressive strength of a concrete increases directly as the cement content, but not in a proportionate ratio. An increase in the ratio of cement to total fine and coarse aggregates when the relative proportions of the latter are not fixed does not necessarily result in an increase in strength. For example, a concrete mixed in the proportion of 1 part cement to 9 or 10 parts of total fine and coarse aggregates combined so as to give a maximum density may have greater strength than a concrete mixed in the proportion of 1 part cement to 6 parts total of the same fine and coarse aggregates, which are not combined to give a maximum density.

With very few exceptions there is a direct increase in strength of all concretes with age. The rates of increase depend upon a number of factors, such as the rate of hardening of the cement, the consistency of the mix, method of mixing and molding, curing, character of aggregate, etc., and therefore no general equation can be written to express the rate of increase in strength, as it will vary for every batch of concrete in which the above factors vary.

Conclusions

The conclusions derived from the tests are collected in the following items:—

1. No standard of compressive strength can be assumed or guaranteed for concrete of any particular proportions made with any aggregate unless all the factors entering into its fabrication are controlled.

2. A concrete having a desired compressive strength is not necessarily guaranteed by a specification requiring only the use of certain types of materials in stated proportions. Only a fractional part of the desired strength may be obtained unless other factors are controlled.

3. The compressive strength of a concrete is just as much dependent upon other factors, such as careful workmanship and the use of the proper quantity of water in mixing the concrete, as it is upon the use of the proper quantity of cement.

4. The compressive strength of concrete may be reduced by the use of an excess of water in mixing to a fractional part of that which it should attain with the same materials. Too much emphasis can not be placed upon the injurious effect of the use of excessive quantities of water in mixing concrete.

5. The compressive strength of concrete may be greatly reduced if, after fabrication, it is exposed to the sun and wind or in any relatively dry atmosphere in which it loses its moisture rapidly, even though suitable materials were used and proper methods of fabrication employed.

6. The relative compressive strength of concretes to be obtained from any given materials can be determined only by an actual test of those materials combined in a concrete.

7. Contrary to general practice and opinion the relative value of several fine aggregates to be used in concrete can not be determined by testing them in mortar mixtures. They must be tested in the combined state with the coarse aggregate.

8. Contrary to general practice and opinion the relative value of several coarse aggregates to be used in concrete can not be determined by testing them with a given sand in one arbitrarily selected proportion. They should be tested in such combination with the fine aggregate as will give maximum density, assuming the same ratio of cement to total combined aggregate in all cases.

9. No type of aggregate such as granite, gravel, or limestone can be said to be generally superior to all other types. There are good and poor aggregates of each type.

10. By proper attention to methods of fabrication and curing, aggregates which appear inferior and may be available at the site of the work may give as high compressive strength in concrete as the best selected materials brought from a distance, when the latter are carelessly or improperly used.

11. Density is a good measure of the relative compressive strength of several different mixtures of the same aggregates with the same proportion of cement to total aggregate. The mixture having the highest density need not necessarily have the maximum strength, but it will have a relatively high strength.

12. Two concretes having the same density but com-

posed of different aggregates may have widely different compressive strength.

13. There is no definite relation between the gradation of the aggregates and the compressive strength of the concrete which is applicable to any considerable number of different aggregates.

14. The gradation curve for maximum compressive strength, which is usually the same as for the maximum density, differs for each aggregate.

15. With the relative volumes of fine and coarse aggregate fixed, the compressive strength of a concrete increases directly, but not in a proportionate ratio as the cement content. An increase in the ratio of cement to total fine and coarse aggregates when the relative proportions of the latter are not fixed does not necessarily result in an increase in strength, but may give even a lower strength.

16. The compressive strength of concrete composed of given materials, combined in definite proportions and fabricated and exposed under given conditions can be determined only by testing the concrete actually prepared and treated in the prescribed manner.

17. The results would indicate that the compressive strength of most concretes, as commercially made, can be increased 25 to 100 per cent. or more by employing rigid inspection which will insure proper methods of fabrication of the materials.

Industrial Wastes

More and more the problem of industrial economy is receiving its due attention. One phase which is especially gaining in importance is the problem presented in the treatment of industrial wastes, by which we mean such materials as are rejected in manufacturing processes and are usually discharged as useless sewage. The sanitary engineer, as well as the chemist and economist, is finding his field rapidly widening in this regard. Usually factory wastes may be classified into two main groups—those which by some inexpensive method of treatment may be made to yield a product of value at least equal to the cost of recovery, and those which contain no materials of value and are discharged at once into a sewer or water course, if such disposal is permitted. The effective separation of these two classes of waste materials at their various sources of origin is an important feature of the problem.

If these materials are discharged untreated into the sewers they impose an added load on a sewage treatment plant and in the case of wastes containing putrescible matter, create a disagreeable nuisance. When the discharge takes place into a water course pollution is liable to develop.

Sometimes, however, the treatment of industrial waste leads to the recovery of valuable by-products and is carried on at a profit. This feature alone has stimulated investigations in regard to the recovery of important materials. The fact that increasing expenses and decreasing returns are making profits less easy to obtain has urged industrial concerns to take up this problem and investigate their processes, in order to reduce their wastes or recover some valuable portion of them that may be of use as a commercial product. Many of the larger concerns are spending huge sums annually for investigation of this matter, realizing that the discovery of by-products might repay the cost of investigation and bring in a return that will more than balance the cost of recovery. The ideas of economy that have been imposed by war have also forced manufacturers to make their processes more efficient.

In some small plants the facilities of the large plant for making by-products are lacking. However, careful inspection by an outside engineer will frequently show leaks which can be stopped at small expense with comparative profit to the manufacturer.

The wastes to be handled vary considerably with the industry, and even among plants of the same industry, according to the processes used and the material produced. Prevalent waste differs in various localities; for example, in certain districts the waste from the packing houses, tanning houses, starch works and distilleries, are the most common; in others pulp and sulphite wastes. Seldom does the manufacturer know just how much waste he is creating. A thorough inspection of the plant in all its details is valuable, for frequently the study of the inside working reveals many points at which waste can be reduced with comparatively small expenditure of labor or material.

No general method of procedure can be stated, as each plant is usually a law unto itself. At times the separation of waste may be desirable, whereas in other cases, as for instance in tannery works, the effluent from one part of the plant contains chemicals that may be of material value in precipitating matter held in suspension in the effluent of another part of the plant. Under those conditions the mixing of waste is of service.

An Improved Tamper for Concrete

The illustration shows a new tamper recently devised for tamping and agitating wet concrete. This form of the tool allows tamping in a mix where the minimum amount of water is used. It has two or three times the surface area of the customary flat iron type and consequently a much larger area can be finished in a given time than with the usual type. The

re-mixing produced by it has an advantageous effect in producing a dense homogeneous mass practically free from air and water voids and breaking up any lumpy masses of concrete. A tamper of this type can be made in several shapes and sizes to suit conditions. It can be obtained with a flat ribbed surface or with square, diagonal, circular or parallel openings, or with knife like blades.

St. Hyacinthe Filtration Plant

In a recent issue of the Contract Record a brief description appears of the proposed filtration plant for the city of St. Hyacinthe, P.Q. The plans and specifications for this work were prepared by Mr. Frederick E. Field.

Illustrating Further Types of Larger Hig

Eben Fulton Bridge.—Upper Stewiacke, Colchester Co., old wooden bridge now replaced by steel

Bingay Bridge.—Barton,

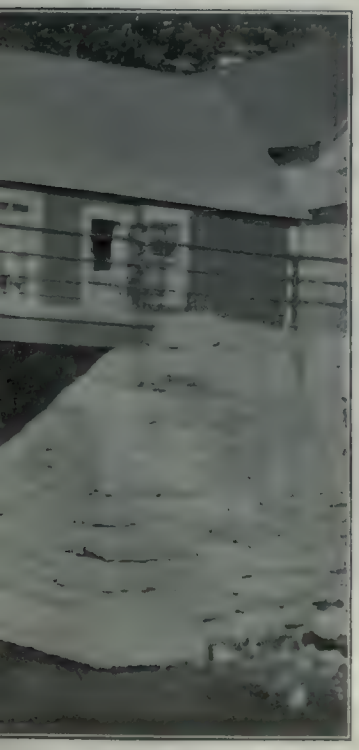
Eben Fulton Bridge.—Upper Stewiacke, Colchester Co., 100 ft. Steel Span on concrete abutments. Erected in 1915

Shaws Bridge.—Bear River, Dig

Bridges of the Province of Nova Scotia

Concrete Arch, Earth-filled

J. N. McDonald Bridge.—Bridgeville, Pictou Co., 24 ft. Span, Concrete Beam and Slab



r Span Rolled I-Beam and Concrete

Sinclair Cameron Bridge.—Bridgeville, Pictou Co., 24 ft. Span, Concrete Beam and Slab

Municipal Factory in the City of Three Rivers, Que.

An Innovation in Municipal Organization

The city of Three Rivers, P.Q., is making an experiment, so far as Canada is concerned, in erecting a municipal factory, from plans by Asselin and Brousseau, Montreal. The idea of this building grew out of lack of immediate factory accommodation for manufacturers who were willing to accept the inducements offered by the city, through Mr. W. J. Shea, Industrial and Publicity Commissioner, of cheap power and labor and tax exemption. These manufacturers did not feel called upon to make the investment necessary for special buildings, neither did they care to wait until such buildings were ready. The city therefore decided to erect a factory which will be rented to manufacturers on a no-profit basis. The general contract was let to Nobert, Dugre, Arsenault, Ltd., of Three Rivers, and the heating contract to Mr. N. Dechesne, of Three Rivers.

The plans show a building something like an L in shape, being 35 feet long, 94 feet deep at one end, 48.8 feet deep at the other, and 55 feet high. It consists of four storeys and a basement, with a boiler house 12 feet from the main building. The foundations are of reinforced concrete; the walls of plastic brick supplied by the St. Lawrence Brick Company; while the remainder of the structure is of mill construction. Each floor is supported by 28 wooden columns. On the first and third floors are the women's toilets, and on the ground and second floors the men's toilets; here the floors are of concrete. The roof is of gravel. Each storey is provided with a fire door and is equipped with sprinklers, and at different points are two fire escapes.

There are two entrances, one on the ground floor on St. George Street, and the other at the rear, the latter giving access to the various floors. An Otis Fenson freight elevator is to be installed near the principal entrance, while a goods platform is provided for the ground floor. The building is exceptionally well lighted by windows on all sides.

A novel feature is the method adopted for disposing of water accumulating on the different floors in the event of fire. At the level of every floor line and between the windows, on inclined planes, scuppers are inserted through the walls, enabling the water to flow to the outside, as the pressure opens a small iron trap on the outside face of the wall, thus releasing the water, and providing protection to the floors below.

The boiler house is a separate building of brick with concrete foundations, 12 feet from the factory. It is 43 x 37 feet, together with a pump room, 24 x 13 feet. The chimney stack is 100 feet high. Provision is made for four boilers, but at present two Taylor-Forbes tubular boilers only are to be installed on concrete foundations. A small Smart-Turner centrifugal pump and receiver direct connected to an electrical motor, will be situated in the basement, and a larger automatic combination steam and electric pump and receiver of the same make will be placed in the pumping room. This will also be direct connected to an electric motor. Between the boiler room and the main factory the supply and return pipes will be laid underground in a trench 5 ft. 6 in. deep. Cast iron radiators are to be set against the walls on each floor. An inclined wooden platform, eight feet from the ground, will be erected in front of the boiler house. This is for the purpose of receiving and discharging coal; the wagons will be drawn up the platform and their contents dumped into coal bins built on the ground at the side of the platform. The latter is supported on wooden posts with concrete footings.

Modern Brick Road Construction*

Use of Old Foundations

While old gravel and macadam roads can be used to great advantage as foundations for new brick surfaces, yet where such roads do not exist it seems more advisable that the foundation be of Portland cement concrete rather than either gravel or macadam, even though of a 2-in. greater depth than the concrete. To utilize economically a gravel or macadam road as the base for a brick surface, there is required greater skill than where all the work is to be new. The establishment of the grade line is a delicate matter, inasmuch as a variation of only 1 in. may require either undue scarifying of the old surface or the unwarranted addition of new gravel or stone which shall be united with the old. In order to establish this grade line properly it is frequently necessary to cross-section the old road at intervals of 50 feet, this depending of course upon the condition of the surface and the regularity of its profile. After having worked out the economic position of the grade line for each station along the line of the improvement, it is usually found necessary that the old surface be sacrificed to some extent in order that the higher places may be removed to make room for a sufficient quantity of the bed for the brick, and that the lower places may be filled up with fresh gravel or stone to avoid an excessive depth of this bed. The sacrificed, reshaped and rolled surface should conform with a permissible variation either way of ½ in., to the contour of the finished brick surface. This rolling should be done with the roller used for the subgrade work, and the compaction of the material should be most thorough.

The curb or edging, if used, may be built of concrete, having a width of from 4 to 6 in. at the top and from 6 to 8 in. at the bottom, the total height of the edging being from 12 to 15 in. While the edging is not really necessary as a pavement feature, yet its use is recommended because of the great convenience it offers as a guide for the templet used to locate to a nicety the areas to be sacrificed. The edging would be constructed, of course, before any of the road is scarified. With the edgings completed the road can be scarified and easily re-shaped and rolled to the proper cross-section and to an alignment conforming strictly with that of the edgings. Where edgings are not used it is necessary that there be set up true to line and grade temporary side forms that will carry the templet used as a guide for re-shaping the old road. From the expense of furnishing, setting up and later removing these temporary side forms there is added nothing of value to the completed pavement. In view of this fact, and also in view of the precision of alignment furnished by the concrete edgings, it will be appreciated why the edgings are generally used, and more particularly when it is considered that the top width of each edging acts simply as a substitute for a corresponding width of brick surface. Upon having thus prepared the old road to serve as a base, it is ready to receive the bedding course upon which the brick are set.

New Concrete Foundation

While there may be found conditions that would warrant the construction of a new gravel or macadam foundation to carry a brick surface, yet these conditions are rare. The Portland cement concrete foundation constitutes the best that has yet been devised for brick roads. For the heaviest rural highway traffic in Illinois the fact seems demonstrated by experience that for an 18 ft. road at 4½-in. concrete base is entirely satisfactory, and for a 10-ft. one, 4 in. will suffice. These dimensions have been used under various soil and traffic conditions, and from every indication they are well on the side of safety.

It has further been demonstrated that the mixture for these bases need not be richer than 1:3½:6. This mixture has been used extensively with various qualities of aggregates. With reasonably satisfactory inspection of the work it is uneconomical to require that the fine and the coarse aggregates be used separately. The use of mixed aggregates, usually termed unscreened gravel, should be permitted with the restriction that one part by volume of cement shall be used to each 3½ parts of fine aggregate contained in the gravel, and that the ratio of the fine to the coarse aggregate shall not be less than 3½ to 6, nor greater than 7 to 6. With the fine aggregate ratio running at the permissible high figure, the value of the additional cement required would be about 7 ct. per square yd. of base. It has been learned from specific cases that where unscreened gravel was shipped by rail for long distances the saving in the purchase and the transportation of the unscreened material as against separated aggregates amounted to more than 7 ct. per square yd. of base. These were extreme cases in transporting materials a long distance, so under conditions where local materials are available the saving by the use of unscreened gravel would be still more. In the construction of country roads, usually having a width of from 10 to 18 ft., there is not conveniently available on the prepared subgrade a sufficient space to pile and use the aggregates separately.

The consistency with which the concrete for the base should be mixed depends upon whether the road is to be constructed monolithic, or with a cushion or bed of some substantial thickness between the base and the brick. If the latter method is to be followed the concrete can be of a rather wet consistency in order to keep down the cost of the work, but of course the consistency should not be such as would permit the separation of the aggregates. If the monolithic method is to be followed a comparatively dry consistency is required in order that the brick may be placed upon the concrete almost immediately. For monolithic work it is essential that the consistency of the concrete be uniform in order that local depressions may not develop due to the weight of the brick and the process of rolling.

Side Forms, Mortar Bet, etc.

For the construction of a brick road having a sand-cement bed wood forms are permitted, inasmuch as these forms must remain in place until at least 24 hours after the pavement is grouted, which means about two weeks after the concrete base is laid. The expense of providing a sufficient length of steel forms to remain in place for two weeks would not be warranted by the advantages gained. For monolithic work, however, steel forms should be required, for the precision of alignment needed to harmonize with the smoothness of the pavement can usually be gotten only by their use.

The specifications of the Illinois Highway Depart-

* By H. E. Bilger, Road Engineer, Illinois Highway Department at Kansas State Conference of Highway Engineering.

ment, edition of March, 1916, provide for both methods of constructing brick roads. By one method the brick are bedded upon a ¾-in. layer of dry mortar of a 1 to 4 mix, and by the other they are built monolithic with the base, a 3/16-in. layer of dry mortar of 1 to 3 mix being placed on the wet base as it is struck off. The use of the sand cushion as such has been abandoned.

By the former method, the order of procedure is practically identical with that in which a sand cushion is used, except that for any particular day's work only such a length of the base is covered by the mortar as can be covered with brick the same day. All of the brick laid on any particular day should be rolled on that day, even though the grouting may not be done until a day or so later. It is essential that the brick not be allowed to remain on the mortar bed over night without being rolled to a true and uniform surface, for, if the mortar bed becomes moistened and sets, no reasonable amount of rolling can produce the smoothness desired.

By the monolithic method with concrete base, the mortar bed and the brick are all placed at practically the same time, or so nearly at the same time that within a period of from 5 to 15 minutes after the subgrade has been covered with concrete the brick are set to place. Usually not more than 10 to 15 lin. ft. of the base is ever exposed without being covered with brick.

Immediately upon placing the concrete on the subgrade it is roughly leveled off with shovels to the approximate thickness desired as determined by a light wood templet used as a gauge. For the success of the monolithic construction the use of a rigid steel templet to strike off the base is essential. The templet thus far used has been of the multiple type, consisting of a 6-in. I-beam in front and a 6-in. channel behind, the two being spaced 2 ft. apart and riding on four rollers which are supported by the steel side forms. The lower or cutting edge of the front templet is located 3/16 in. below the corresponding edge of the rear templet. When a 4-in. brick is used the lower edge of the rear templet is set exactly 4 in. below the top of the steel forms. The space between the two templets is kept filled with dry mortar consisting of one part cement to three parts sand. As the templet is drawn forward by a cable attached to the mixer the base is struck off to a smooth surface and a 3/16 in. layer of the dry mortar is distributed evenly over the wet concrete.

Laying Rolling, Grouting, etc.

After the greater portion of the culling of the brick is done at the pile at the side of the road, the acceptable brick are carried to the setters on pallets and placed in stacks upon the brick pavement with the lugs all in one direction. Inasmuch as the final rolling of the brick should be done within 30 min. from the time the concrete is laid, it is important that the culling after their having been laid in the pavement be kept to a minimum. The brick are then set upon the mortar by men standing on the brick already laid. The rolling of the brick is usually done with a two-section 800 lb. roller, about 24 in. in diameter and about 30 in. long. One man can readily operate the roller.

Just before the grouting begins the surface of the brick is sprinkled with water to avoid absorption from the grout. The grout filler consists of a 1 to 1 mix of cement and sand, the sand not containing more than 3 per cent. by weight of organic matter and clay combined, nor more than ½ of 1 per cent. of organic matter. The sand should be rather uniformly graded from the finest to the coarsest particles, and it should all be such size as to pass through a 1/16 in. square mesh sieve. Not more than 30 per cent. by volume, however, should pass a sieve having 50 mesher to the inch.

Value of Hydrated Lime in Mortar

The slaking of quicklime is an operation which is almost invariably carried on by laborers who have little or no conception of the importance of their task. As a result, many failures have been charged to lime in the past which actually were due to improper preparation during the slaking operation, and a new product known as hydrated lime, which has been offered widely to the trade in recent years has met with much success. Hydrated lime is a dry flocculent powder resulting from the slaking of quicklime by mechanical means, with an amount of water which is sufficient to satisfy the calcium oxide, but insufficient to make a paste or putty. Hydrated lime is manufactured in mechanical hydrators in which the batches of quicklime and water used are carefully proportioned by weight. After passing from the hydrator, the material is subjected to a mechanical system of separation which eliminates the coarse or impure particles which may cause popping, etc. It is sold in bags of definite weight and requires only to be mixed with sand and water to make the mortar. Several of the more prominent manufacturers of hydrated lime employ chemists who regularly superintend the manufacture of hydrated lime, just as the chemists in Portland cement factories superintend the proportioning of the raw mix going to the kilns to be burned for Portland cement. The hydrated lime manufactured under such chemical supervision is a reliable product free from tendencies which might give rise to popping, pitting or disintegration.

Hydrated lime of good quality may be used for almost any purpose for which lime mortar is used, and is by some considered a more reliable product than quicklime. Among the newer uses may be mentioned its employment in cement mortars and concrete. An addition of about 15 per cent. of hydrated lime to cement mortar or concrete decreases its permeability to water, reduces the cracking due to shrinkage, etc., and increases the plasticity of the mortar or concrete, thus preventing separation of the sand, stone and cement and causing the mixture to flow and fill the forms more readily.

Tests on Hydrated Lime

Tests on this material have recently been performed by Professor Macgregor, of Columbia University, the object being to determine the strength and elastic properties of brick masonry construction when laid up in various mixtures of mortar in which hydrated lime was used, and also to observe the effect of the water carrying capacity of hydrated lime in retaining moisture in the mortar that would otherwise be absorbed by the bricks.

The investigation consisted in laying up 7 different sets of brick piers, 8 ins. square and 7 ft. high, each set consisting of 9 piers laid up in mortar of different proportions as follows: 1 part cement to 3 parts sand;

1 part cementing material to 3 parts sand, the cementing material being made up of cement supplemented by the following percentages of hydrated lime—10, 15, 25, 50 and 75; and finally a mix of 1 part hydrated lime and 3 parts sand. All mixes and replacements were made by volume. Three piers of each set were tested under compression to the point of rupture at three different periods, namely, 7, 28 and 90 days. The bricks used in these piers were hard-burnt face bricks. Seven common brick piers were also set up with the same mortar mixes and tested at the end of 28 days. The object of this last series was to ascertain whether or not the same general relations would hold when common rather than face brick were used. The mortar joints were ⅜ in. throughout and headers were placed every sixth course. The results of the ultimate strength tests on face brick piers are recorded in the following figures:

Mix No.	Age 7 days	Age 28 days	Age 90 days
1	2630	2840	2840
2	3080	3170	4435
3	2890	3230	4300
4	3120	3470	4170
5	2670	3100	3820
6	1945	2370	2720
7	1535	1870	1950

It is observed that there is an increase in the strength of the brick columns until mix No. 5 is passed. This indicates that reasonable amounts of hydrated lime in the mortar aids its resistant qualities. In the report of these tests the following three conclusions are arrived at:

First. The replacement of Portland cement by hydrated lime renders a more plastic mortar which spreads easily on brickwork and in consequence insures more uniform bedding and this with less care.

Second. The so-called "suction" of the brick which steals a great deal of moisture from Portland cement mortars has been noted to effect lime-cement mortars to a much less degree. The addition or replacement by hydrated lime aids in the retention of moisture.

Third. Moisture which is lost due to causes cited probably leaves the mortar with an insufficient amount to completely hydrate or properly hydrate the Portland cement, a condition which is largely overcome by the use of hydrated lime.

The test on the common brick piers showed the same general trend of results, that is, that hydrated lime increased in general the strength of cement mortar.

Less Expensive

One of the great advantages of hydrated lime is that it saves material, thereby producing a saving in dollars and cents. For example, mortar No. 1, a 1:3 mix of cement and sand, contains by weight 100 lbs. of Portland cement to 300 lbs. of sand. Mixture No. 5, which is a 1:1:6 mixture of Portland cement, hydrated lime and sand, contains by weight 50 lbs. of Portland cement, 20 lbs. of hydrated lime and 300 lbs. of sand. This means that in this latter mix there are 70 lbs. of cementing agent to 300 lbs. of sand, as compared with 100 lbs. of cementing agent to 300 lbs. of sand in the case of mix No. 1. Therefore the saving in cementing material is approximately 30 per cent., while the ultimate strength of the piers set up with mortar No. 5 is greater than that of piers set up with mortar No. 1. Hence, assuming the same price by weight of cement and hydrated lime, the latter possesses an economic advantage in having greater strength at less expense.

Revised Cement Specifications

At the recent meeting of the American Society for Testing Materials held at Atlantic City, N.J., a new set of specifications for Portland cement was recommended. After four years of labor the Committee on Cement presented a revision of the requirements for Portland cement, in the present standard specifications for cement, adopted in 1904 and slightly revised in 1908 and 1909. The latest revision consists in an entire rewriting with a number of changes in the requirements and the incorporation in them of the method of making the tests. The requirements for natural cement have not as yet been revised, although the new methods of making tests will apply to the natural as well as to the Portland cement.

Below is given the clauses of the specifications that relate to the requirements. In addition there are a large number of sections relating to the methods of testing. The main differences between it and the old A. S. T. M. standards are as follows:—

Fineness has been increased from 75 per cent. to 78 per cent. through a 200-mesh screen, with no prescription for the 100-mesh screen in the new specification. The permissible SO_3 content has been increased from 1.75 per cent. to 2 per cent. and the MgO content from 4 per cent. to 5 per cent. The time of initial set has been increased from 30 min. to 45 min. as read on the Vicat needle and an alternate permission to use the Gillmore needle has been included. The neat test for tensile strength has been omitted and the 28-day tensile requirement for 1:3 mortar briquettes has been increased from 275 lb. per sq. in. to 300 lb. per sq. in. The normal air and cold-water tests for soundness have been eliminated and only the steam test retained.

The first fifteen clauses of the specifications follow:—

1. Portland cement is the product obtained by finely pulverizing clinker produced by calcining to incipient infusion an intimate and properly proportioned mixture of argillaceous and calcareous materials, with no additions subsequent to calcination excepting water and calcined or uncalcined gypsum.

I. Chemical Properties

2. The following limits shall not be exceeded:—

Loss on ignition, per cent.	4.00
Insoluble residue, per cent.	0.85
Sulphuric anhydride (SO_3), per cent.	2.00
Magnesia (MgO), per cent.	5.00

II. Physical Properties and Tests

3. The specific gravity of cement shall not be less than 3.10 (3.07 for white portland). Should the test of cement as received fall below this requirement, a second test may be made upon an ignited sample. The specific gravity test will not be made unless specifically ordered.

4. The residue on a standard No. 200 sieve shall not exceed 22% by weight.

5. A pat of neat cement shall remain firm and hard, and show no signs of distortion, cracking, checking, or disintegration in the steam test for soundness.

6. The cement shall not develop initial set in less than 45 min. when the Vicat needle is used, or 60 min. when the

Gilmore needle is used. Final set shall be attained within 10 hr.

7. The average tensile strength in pounds per square inch of not less than three standard mortar briquettes (see Par. 57), composed of one part cement to three parts standard sand, by weight, shall be equal to or higher than the following:—

Age at Test, Days	Storage of Test Pieces	Tensile Strength, Lb. per Sq. In.
7	1 day in moist air, 6 days in water	200
28	1 day in moist air, 27 days in water	300

8. The tensile average strength of standard mortar at the age of 28 days shall be higher than the strength at 7 days.

III. Packages, Marking and Storage

9. The cement shall be delivered in suitable bags or barrels with the brand and name of the manufacturer plainly marked thereon, unless shipped in bulk. A bag shall contain 94 lbs. net. A barrel shall contain 376 lbs. net.

10. The cement shall be stored in such a manner as to permit easy access for proper inspection and identification of each shipment, and in a suitable weather-tight building which will protect the cement from dampness.

IV. Inspection

11. Every facility shall be provided the purchaser for careful sampling and inspection at either the mill or at the site of the work, as may be specified. At least 10 days from the time of sampling shall be allowed for the completion of the 7-day test, and at least 31 days for the 28-day test. The cement shall be tested in acocrdance with the methods hereinafter prescribed. The 28-day test shall be waived only when specifically ordered.

V. Rejection

12. The cement may be rejected if it fails to meet any of the requirements of these specifications.

13. Cement shall not be rejected on account of failure to meet the fineness requirement if upon retest after drying at 100° C. for one hour it meets this requirement.

14. Cement failing to meet the test for soundness in steam may be accepted if it passes a retest using a new sample at any time within 28 days thereafter.

15. Packages varying more than 5% from the specified weight may be rejected; and if the average weight of packages in any shipment, as shown by weighing 50 packages taken at random, is less than that specified, the entire shipment may be rejected.

Industrial Uses of Hydro-Electric Power*

At the present time the great steel mills of this continent are absolutely dependent upon the electric furnace for the production of alloys. The automobile manufacturer is dependent upon another electric furnace production, aluminium, for car bodies. The manufacturer of steel products needs these materials for making tools, and countless factories require abrasives which cannot now be imported, and which are now being produced, in the United States at any rate, only by electric processes. Without acetylene gas and graphite, and other electric products, many existing industries would be absolutely crippled.

So far as the products of electro-chemistry are concerned, it is found that the surgeon and the doctor look to electric plants for chloroform and disinfectants; the cotton and the paper manufacturers need the bleaches produced by electricity; the user of soap patronizes the electro-chemical establishment, as does every user of matches. Gold and silver mining of the west requires electric products to assure a profit, and it is only lately that the United States, cut off from its supply of German dyes, has found itself dependent upon electric products to supply the deficiency, in part at any rate.

These are but a few of the industries dependent upon cheap electric power. The further development in either Canada or the United States, or the inauguration of such processes in Canada, is very largely, if not altogether, dependent upon cheap available, dependable power. The source of such power is admittedly, for a very large portion of our country, water-power. The development of water-power in making available a supply of cheap hydro-electric energy in various parts of the Dominion, would probably result in the reduction of the cost to the consumers of countless articles of every-day use, which, to the man on the street, are in no way associated with hydro-electric development.

To be more specific, the manufacture of steel is one of the greatest of the United States industries, and is fast becoming a very important one for Canada. To-day, electrically produced ferro-silicon is used as an alloy by most steel manufacturers, with the result that the Bessemer process is fast becoming obsolete. The essential element in the manufacture of armour plate and armour-piercing projectiles, is introduced into steel by the alloy, ferro-chromium, strictly an electric furnace product.

Ferro-chrome, another product of the electric furnace, has made possible the manufacture of high-speed tools, which in turn have tripled the capacity of our machine shops and enhanced the efficiency of our mechanics. It has cut to one-third the capital invested in tools to accomplish a given volume of work.

In the absence of chromium, tungsten, vanadium and molybdenum, all alloys made by electrical processes, the builders of American battleships and other weapons of national defence, and a large portion of our Canadian steel and metal-working industries and other industries, would be in the condition of twenty years ago. The electrical industry itself is largely dependent upon silicon steel, a product that does not age and does not wear.

The development of aeroplanes also calls for aluminium, and only with the abundant production of cheap electric energy from water-power will the price of aluminium kitchen utensils come within the reach of every housewife.

At the outbreak of the war, we were cut off from the supply of Greek and Turkish emery. To-day the metal-working industries of this country are dependent almost entirely upon electric furnace abrasives, carborundum and alundum. The manufacturer of agricultural machinery, locomotives, firearms, milling machinery, automobiles, and countless other metal products must have these abrasives, and they can now be made only where waterpower is developed cheaply.

The electric furnace also turns out calcium carbide, the only source of acetylene, which is being so extensively used in Canada. The oxy-acetylene flame has become of intense value in the welding of metals and the cutting of steel. This same calcium carbide is the important factor in the fixtation of atmospheric nitrogen, and is the source of supply upon which we may have to rely for nitric acid and nitrates employed in making munitions of war and fertilizers.

All the artificial graphite used in the world to-day is produced at Niagara Falls, by cheap waterpower. Its uses are manifold. Practically the whole supply of abrasives on this continent is from Niagara.

Considering the products of electro-chemistry alone, chlorine stands out as of first importance. The sterilization

* By J. B. Challies, Superintendent Dominion Water Power Branch, in Trade and Commerce Weekly Bulletin.

of water supplies of countless cities has been made possible by the use of bleaching powder or hypochlorite, and in communities where this is used extensively, typhoid has been largely eliminated. The armies of Europe use chlorine to avert typhoid, and other chlorine products, including chloroform, are used surgically, both as anesthetics and antiseptics. This same chlorine, or bleach, makes possible the manufacture of white cotton goods and white writing paper. Other products of chlorine, produced electrically, enter into the manufacture of soaps. Even into fire extinguishers goes this product of cheap electricity.

To meet the shortage in coal-tar dyes, by the combination of chlorine with coal-tar benzon and tuluol, there is now beginning to be produced quantities of those necessary intermediates formerly made and exported from Germany.

Metallic sodium, also a product of electricity, is the basis for sodium peroxide, which is used in generating oxygen for hospitals, for laboratories, and for submarines and mine-rescue apparatus. It also enters into the manufacture of hydrogen peroxide. Without sodium cyanide, many gold and silver mines could not possibly operate at a profit.

These are but a few of the products of every-day use which will largely depend upon water-power. Many of these, a few years ago, had no known value. What other products remain to be developed with the growth of electricity, no one can predict.

There can be no question regarding the fundamental and essential relation of water-power to the economic and industrial situation in Canada.

Canadian Industry, Commerce and Finance

Canadian business men, and those in other countries doing business, or prepared to do business in Canada, have no doubt felt the need of a concise and accurate source of information concerning Canadian industry, commerce and finance. Such a volume has just been published by the Industrial and Educational Press, Limited, 45 St. Alexander Street, Montreal. The opening chapters of the book are devoted to a discussion of modern business methods as applied to Canada, in which the author deals with the three divisions—industry, commerce and finance.

The "industry" section deals with each of the various branches of Canada's industrial development, in point of extent, production and possibilities. In his treatise on commerce the author treats the subject in all its phases, foreign commerce, domestic commerce, ocean transportation, inland water transportation, railroads, etc., are taken up in turn and the methods and terms explained. The various markets of the world are described, and a section is devoted to weights and measures in use the world over. The section on finance deals with a wide array of subjects. The author first describes the development of banking and instruments of credit, and then deals with all methods in present use describing each separately—foreign exchange, bills of lading and shipping receipts, etc., mortgages, liens, deeds, stocks, bonds, and all classes of insurance are given attention in this chapter. Another useful and principal feature of the volume is the trade index or directory of all marketable commodities and Canadian producers. This list embodies a description of most commodities and and accurate lists of the Canadian producers of each, with addresses.

The book is published by the Industrial and Educational Press, Limited, Montreal, as a companion volume to the Journal of Commerce, of which the Hon. W. S. Fielding is President and Editor-in-Chief.

The volume should prove of particular value to the young business-man and to foreigners doing business with Canadian merchants. The information is especially useful to Canadian merchants at the present time when so many firms are beginning to do an export trade, to which a considerable portion of the book is devoted.

Personal

Mayor R. D. Waugh, of Winnipeg, Man., has been appointed chairman of the Commission of the Greater Winnipeg Water District, succeeding the late S. H. Reynolds.

Mr. Fred A. Robertson, Science, Toronto, '08, has resigned from the engineering sales staff of the Canada Cement Co., Ltd., to accept a position with the Ontario Hydro-electric Power Commission.

Mr. A. M. Morrison, of the Canadian Engineers of the British Army, has been awarded the Distinguished Conduct Medal for conspicuous gallantry. He also has received a commission as lieutenant in the Canadian Engineers. At the outbreak of war Mr. Morrison was an engineer engaged in the construction of the Pacific Great Eastern Railway in British Columbia.

Mainly Constructional

East and West—From Coast to Coast

Gauthier & Cie, general contractors, Montreal, Que., have registered.

The Drayton Silo Company, Limited, Drayton, Ont., have obtained a charter.

The Superior Tile Company, Limited, has been incorporated with a capital of $40,000, head office, Montreal, Que.

The Manitoba Steel Foundries, Limited, has been incorporated with a capital of $300,000; headquarters at Winnipeg, Man.

The Chapman Engine & Manufacturing Company, Limited, has been incorporated with a capital of $250,000, headquarters at Dundas, Ont.

The building permits issued at Port Arthur, Ont., for April this year totalled 38, representing a value of $49,440, as compared with 47 in April, 1915, value $17,077.

Letters patent of incorporation have been issued to the Independent Paint & Varnish Company of Canada, Limited. Capital stock, $200,000. Chief place of business, Montreal.

The city officials of Calgary, Alta., are endeavoring to get information concerning waterworks and filtration plants of Canada, and have sent inquiries to various cities of the Dominion.

Wentworth county council have approached the Hamilton board of control in regard to the paving of the Beach Road, and it is possible that a permanent pavement may be laid this year.

The bridge over the River Speed at Hespeler, Ont., has been completed. The cost will total some $30,000. The bridge has been made much stronger and will allow heavier locomotives to go over.

The contractors for the new G. N. R. depot at False Creek are Messrs. Grant, Smith & Company, and Macdonell, Limited, and the railway company have submitted to the Vancouver city council the wages schedule of the men to be employed on the construction work, who, they say, are all citizens of Vancouver. The council is making a very strong protest against the company using terra cotta on the depot and on the sea wall and will urge them to use British Columbia stone.

The question of paving Davenport Road, Toronto, is

under consideration. The city proposes to macadamize the road, but the ratepayers of the district are raising objections and demanding a more permanent type of pavement.

Letters patent of incorporation have been issued to Gunn, Richards & Company, Limited, who will carry on the business of consulting and production engineers, as well as other lines of work, with a capital stock of $50,000; headquarters at Montreal.

It is stated that faulty drainage has had a deteriorating effect on the piers of the Bank Street high level bridge over the Rideau Canal, Ottawa, and that the city is now finding it necessary to put in new drains and repair some of those put in by the contractors who erected the bridge.

The Canadian Briscoe Motor Company are taking over the old electric light building and premises at Brockville, Ont., and will install a pressed-steel plant there for manufacturing parts for auto accessories. T. Storey, the president of the company, said that more houses for workingmen would be needed and told of what the company had done to erect such homes in Jackson, Mich.

The excavation for the Rogers Pass (Selkirk) Tunnel was completed on July 16, and the great enterprise was baptized by His Royal Highness the Duke of Connaught. There is still much work to be done on the sides and roof, and it is stated that it will probably be another two months or more before the tunnel is put in operation. A. C. Dennis is the superintendent for the contractors, Foley Bros., Welch and Stewart.

The survey of the Ottawa-Prescott highway has been started from Prescott, as the first portion of the route has been definitely selected. It runs east from Prescott for about three miles to Johnstown and then north to Spencerville. As regards the second portion of the route, Ottawa motorists are in favor of adhering to the riverside, but opposition to this is met with from some of the municipalities in North Gower.

No. 1 Construction Battalion C. E. F., continues to make steady progress, and an excellent class of men are being recruited. A classification has just been completed of the various trades of those recruited at Montreal, which shows the following: blacksmiths, bricklayers, carpenters, concrete workers, construction foremen, draughtsmen, surveyors, iron workers, locomotive engineers, mechanics, miners, stationary engineers, trackmen, etc. This is typical also of the Toronto detachment, which is now over strength.

The home for orphans and old folks which the I. O. O. F. of Manitoba intend to build in Winnipeg will be erected in the vicinity of the old agricultural college, where a site of ten acres has been secured. Steps are to be taken at once to get the preliminary work in connection with the scheme completed, with a view to having the home ready for occupancy next year. The ultimate height or capacity of the building has not yet been decided upon, but the foundations will be laid for extensive premises. One unit, large enough to meet the requirements for the next five years, will be proceeded with first of all.

The Granby Consolidated Mining, Smelting & Power Company is building at Anyox, B. C., a large modern auxiliary steam power plant, having a capacity of approximately 7,000 h.p. The work is being done by the Taylor Engineering Company, consulting and contracting engineers, of Vancouver. The new steam plant will be used to supplement the present water power plant and is expected to be in service towards the end of this year. The total cost is estimated to be in the neighborhood of $700,000.

The American Brakeshoe and Iron Castings Company, of Mohawk, N. J., propose to erect a large foundry at St. Thomas, Ont., and have awarded the contract for its erection to A. E. Ponsford, Limited. The structure will be 225 x 50 feet, one storey high, and will be located adjacent to the Canada Iron Foundry plant on Talbot Street. The plant will manufacture all the Canadian orders for the American Brakeshoe Company, which have hitherto been made in the United States, and will employ about 100 men. C. D. Pettit, of New York, is president.

Arrangements have been completed and work is starting on the new fish hatchery to be built at Normandale, Ont. The main building will be of concrete, 45 ft. x 20 ft., and will be built on the site of the old flour mill. A dam will be constructed about a quarter of a mile west of the hatchery to create a basin of water for cooling purposes and the water will be conveyed across by a runway. The capacity will be about 120,000,000 fish annually. The plant will be constructed by day labor under the superintendence of Dr. Burt, of the Department of Marine and Fisheries.

A scheme was recently brought before the council of the Ottawa Board of Trade by Mr. Cauchon, C. E., which he proposes as an alternative to the Georgian Bay route and the enlarging of the St. Lawrence lock system. Mr. Couchon suggests the construction of a canal through the farming country between Cardinal and Ottawa and improvement works on the Ottawa River between the capital and Montreal, so as to form a waterway for ocean-going ships from the head of the great lakes to Montreal in conjunction with the new Welland Canal. His plan is to use the Ottawa River route from Montreal to Ottawa, 120 miles, and to build a new canal from Ottawa 50 miles across to Cardinal on the St. Lawrence above the rapids, at Lake Ontario level, utilizing the Welland Canal and great lakes route to Port Arthur. Mr. Cauchon estimates that this plan would give a 25-foot draft inland through deep waterway to tide water, at a saving to this country of one hundred millions of dollars over the cost of either the Georgian Bay Canal or the deepening of St. Lawrence canals.

The C. P. R. Union Station at the city of Quebec will be completed by August 1st, it is announced. There are 250 men employed in the construction, finishing the interiors, road work and platforms in the rear. There are three parts to the station, the concourse, office and express buildings. The concourse is 172 ft. x 65 ft. in dimensions and 55 ft. high; the main building is 160 ft. long by 60 ft. wide and 100 ft. high; and the express room, 150 x 50 ft. and 50 ft. high. The floor material used throughout is terrazzo, except in the ticket lobby, where the floors are of marble. The roof of the structure is of copper. A roadway 60 ft. wide and a 12-ft. sidewalk are nearly completed and the ground is being levelled all around. Downing, Cook, of Montreal, are the contractors for the building, which will rank amongst Canada's finest union stations, its cost being in the neighborhood of $400,000. Its architecture is in the old Roman style. There will be eight tracks in the new station and the following companies will have accommodation when it is completed: C. P. R., Transcontinental Railway, and probably the Quebec Central Railway, when the Quebec bridge is finished.

Obituary

As the result of an accident, Mr. George J. Conway, of the firm of Archambault and Conway, contractors, Montreal, died in Lachine General Hospital on July 14. Mr. Conway was superintending some work on the roof of a new munitions plant at Lachine, and to escape being hit by a derrick jumped to another roof, about 16 feet below. He was very severely injured, and died five days after being taken to the hospital. He had expected to go overseas in the fall as N.C.O. in a pioneer battalion.

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B. C. Timber in Construction Work

MANY of our readers will doubtless have noticed the campaign of publicity now being carried on by the Government of British Columbia regarding the general applicability and, in consequence, the desirability of the more general use of British Columbia timber and lumber in almost every kind of construction work. Not only have frequent advertisements appeared in our technical magazines and in the press, but an eastern office has been fitted out, in Toronto, where an able and enthusiastic representative, in the person of Mr. L. B. Beale, who keeps in close touch with the building trades, devotes his entire time to displaying the beauties and expounding the merits of the timbers of our western coast province. Already there is convincing evidence that the policy of the western government is bearing fruit, for there is no doubt that builders and consumers alike, in the east, are discussing British Columbia timbers more and showing a growing desire to become acquainted with their good qualities.

This movement on the part of the British Columbia Government is naturally creating a very favorable business atmosphere for the lumber dealers of that province, who, we have little doubt, will seize the opportunity to further their commercial connections in eastern Canada by carrying large and well-assorted stocks, so that prompt delivery in any quantity may be made. Without this co-operation on the part of the lumbermen of that province, however, the seeds now being sown by the British Columbia Government will result in a much less fruitful harvest than their very progressive advertising methods would lead us to expect. The field in eastern Canada, and Ontario especially, where our forests are much depleted, is very great, but the lumbermen of British Columbia must remember that this field is open to other great lumber-producing sections on this continent as well as to themselves. The success or otherwise of the present effort of the British Columbia Government will hinge very largely, therefore, on the immediate action of the lumber producers and dealers of that province.

Accurate Maps With the Camera

PHOTO-TOPOGRAPHICAL methods are now being employed in survey work with eminently satisfactory results, in cases where the cost of a complete plane-table survey would be considerable or where funds for special surveys are not immediately available. We take from the Engineering Record the following information regarding a camera survey of the Columbia National Forest in Washington. This contains about 1,000,000 acres of very rough and heavily timbered land, making the cost of a special survey rather large. The engineers of the forest service worked out a scheme whereby accurate maps have been produced with the camera, at a cost of only $4.60 per square mile.

The work has been handled almost entirely by one man with a single man as assistant and packer, two sadle horeses and two pack animals. The open seasons were spent in field work and the winter in working up the notes. An average of about 93 square miles was covered each month, observations and photographs being taken when the weather was good and camp being moved or level areas traversed roughly where the weather conditions were unsuitable. In this way accurate maps have been produced and in the course of continued experience special and particularly convenient methods have been developed and applied.

Method Employed

The usual practice was to make four exposures at each station, each embracing the view at a 65-degree angle. Special care is required in the selection of stations, both as to the number of reference points visible and the view of adjacent slopes which the station commands. The most useful views are taken when the shadows are such as to bring out the contours of the hills. About 15 stations are occupied each month and the usual contour of the territory covered is such as to require about 16 stations to 100 square miles. Averages for the seasons in which the field work was carried on show that the stations were occupied on 30 to 40 per cent. of field days, that 32 per cent. of field days were spent in moving camp, and that phohographs were not available on account of smoke fog rain or rain on 32 per cent. of field days.

The primary triangulation has already been done by the Coast and Geodetic Survey. The cost of the

field work was made up of the salaries of the photographer and packer, provisions and photographic supplies, the use of four horses and their maintenance. This averaged $2.76 per square mile of field work.

In the office, the topographer works up fifty square miles each month. The scale is one inch to the mile and the contour interval is 100 feet. The primary points located by the Coast and Geodetic Survey are first made out and from thence the locations and stations selected by the topographers put in, using the photographs and a method of intersection or re-section according to conditions. There are nine primary survey points in the forest, with fifteen main locations, used by the topographer in orienting the remaining 200 locations. All these points are located on the map by plotting with an accurate protractor.

Cost

The cost of the office work averaged $1.85 per square mile, so that the total cost of the survey came to $4.60 per mile. The cost of a plane-table survey has figured out about $6.15 per square mile, besides which, only 53 square miles were covered per month.

Fees for Engineers

THE Association des Anciens Eleves de l'Ecole Polytechnique of Montreal have recently issued a little booklet containing a code of professional etiquette and a tariff such as in their opinion consulting engineers are justified in requiring. The code points to the importance of the engineer's work and to the prime necessity that this should be carried out in a straightforward, honorable, unbiased manner. The tariff is particularly interesting, and though it is open to question whether an association of this sort can reasonably establish a fixed tariff for the services of its members which must not only be varied in value depending not only on local conditions, but also on the ability of the engineer, yet the tariff will at least have the effect of pointing out to municipalities, and others engaging engineers, approximately what an authoritative consultant considers himself worth. At the same time it will tend to stiffen the backs of the engineers themselves in demanding at all times a remuneration commensurate with the services performed.

Distinction is made between simple consultations and consultations followed by a report. For the former the base of charges is placed at a minimum of $50 per day and the length of day is named as six hours.

Where a written report is required the preliminary examination of the project should be charged for at the rate of $50 to $100 a day for the first five days, and at $25 to $50 daily for the remaining time, general expenses to be borne by the client.

In larger projects where the percentage basis is more likely to be acceptable, it is suggested that a preliminary study should be charged for at the rate of 2 per cent. of the probable cost of the enterprise if this latter sum is between $10,000 and $50,000. Up to $100,000 the percentage is 1½ per cent., and above this 1 per cent. For the preparation of plans and designs of construction, charges should be 3 per cent. if the total cost is less than $50,000. For more expensive propositions 2½ and 2 per cent. is considered the proper charge.

Where the work is to be carried through under the superintendence of the engineer the fixed rate is 5 per cent. on any work costing more than a million, with 6 and 7 per cent. for smaller expenditures, the minimum remuneration being placed at $700. The total percentages, therefore, which an engineer may charge for preliminary investigation, plans, specifications and final supervision would amount to from 8 to 12 per cent., depending on the size of the enterprise. A minimum amount of $500 is placed on works costing less than $10,000; $700 on work costing between $10,000 and $50,000; $1,000 for larger work, up to $100,000; and $1,500 for work up to half a million. For enterprises larger than this the remuneration should be by mutual arrangement.

Convention of Union of Canadian Municipalities

The programme of the 16th annual convention of the Union of Canadian Municipalities has been issued, outlining the proceedings of the convention to be held at the City Hall, Montreal, on August 21-22-23.

The opening morning will be given over to an address of welcome by Mayor Martin, of Montreal, and the reply and presidential address by Mayor Church, of Toronto. The remainder of the day's session will be taken up with the report of the honorary secretary-treasurer, Mayor Waugh, of Winnipeg, a review of the activities of the Union, by W. D. Lighthall, Westmount; financial report, by the assistant secretary, G. S. Wilson; report of the Union's parliamentary agent, Fred Cook, Ottawa; and reports from the affiliated provincial unions, including Messrs. R. Forke, Manitoba; H. Bose, British Columbia; A. W. G. Allen, Alberta; W. F. Heal, Saskatchewan; A. Roberts, Nova Scotia; J. W. McCready, New Brunswick; A. Angers, Quebec; the secretaries of the various provinces. The evening session on Monday, August 21, includes papers or addresses on the following topics:—

(1) Municipal responsibility in Canada's preparedness—Frederick Wright, Montreal.
(2) Returned soldiers—A. R. Doble, Montreal.
(3) The patriotic fund—Sir Herbert B. Ames, M.P.
(4) Immigration—J. D. Page, M.D., Quebec.
(5) Public employment offices—B. M. Stewart, Ottawa.
(6) Encouragement to industries.
(7) The town planning outlook—Thomas Adams.
(8) Proportional representation—Howard S. Ross, K. C.

Tuesday, August 22

(9) Good roads movement and its influence on urban municipalities—J. Duchastel, C. E.
(10) Daylight saving—Mayor Church, Toronto.
(11) Hydro-electric railway system in Ontario—T. J. Hannigan.
(12) The new model charter of the National municipal league—C. R. Woodruff.
(13) A study of a city's sinking fund—Thomas Bradshaw, Toronto.
(14) Municipal finance—Sir Frederick Williams-Taylor, Bank of Montreal.
(15) Municipal accounting—E. T. Sampson, Outremont.
(16) How best to introduce modern systems of municipal work—Horace L. Brittain, Toronto.
(17) Municipal assessment—Robert Ryan, Three Rivers.
(18) Forms of municipal government—W. D. Lighthall.
(19) Aldermen and committees—Emery Larviere, Montreal.
(20) Controllers and council—J. W. Nelson, Ottawa.

(21) Commission only—W. D. L. Hardie, Mayor of Lethbridge, Alta.
(22) Manager—P. W. McLagan, Westmount.
(23) The ideal form of civic government and administration—C. J. Yorath, Saskatoon.
(24) Provincial departments of municipal affairs—J. N. Bayne.

Wednesday, August 23

(25) City bill board advertising.
(26) Teaching of civic government in public schools.

Garbage Destructor Plant Pays

The city of Westmount has for seven years been operating a garbage destructor plant of the Heenan & Froude type. The last annual report covering the revenue and expenditures for the year ended October 31, 1915, shows that the total revenue from this plant amounted to $21,996.03, made up as follows:

Revenues

Fuel value of refuse consumed and charged to the electric light plant.	$9,562.80	
Interest earned	606.18	
From the Health Dept. for destruction of refuse for the year ...	11,828.05	
		$21,997.03

Expenditures

Operating expenditures.	$13,057.28		
Interest on debenture bonds	4,323.59		
Sinking fund for retention of bonds	1,060.62		
Loss on sale of bonds.	53.78		
		$18,495.27	
Surplus		3,501.76	
			$21,997.03

The capital cost of the destructor plant equipment is placed at $106,062, so that the sinking fund mentioned under heading of expenditures is one per cent. towards the replacement of the plant. The reserve for depreciation, $3,501.76, is approximately another 3½ per cent., so that after operating expenses and bond interest have been paid a very satisfactory depreciation percentage has been earned on a basis which considers the life of such a plant as approximately 15 years. As this would appear to be a liberal allowance, the Westmount garbage destructor plant may be considered a sound investment.

Girls' School in Montreal

Mr. C. Bernier, architect, Montreal, has designed the plans for a girls' school for the R. C. Commissioners of St. Gregoire de Thaumaturge. The school will be erected on a site 175 x 62, fronting on Gilford Street, at the corner of Delorimier Avenue, Montreal. It will be of four storeys; the foundations are to be of concrete, and the exterior of cut stone for the first floor and of rustic brick (supplied by the St. Lawrence Brick Company) for the balance. The frame will be supported by 56 concrete columns. The first floor will contain a large recreation hall, the heating appliances, and caretakers' apartments, while the other floors are for the 26 class rooms. Corridors run through the centre of these three floors; on the rear side class rooms and toilets are to be placed, and on the side fronting on Gilford street the space is taken up entirely by class rooms, which are all provided with locker accommodation.

The class room partitions will be of terra cotta and plaster, with the ceilings of plaster, and the interior finish of red wood. The toilets and entrances to the buildings are to have ceramic mosaic flooring.

The plans show four entrances, one at each end, and two in the centre of the school on Gilford street. The main entrance to the hall is on the ground floor, and that to the school on the next floor, the latter being reached by means of a double set of steps of Stanstead granite. Two columns at the side of the main school door are also of the same material, with cut stone ornamenting the brickwork round and above the entrances. A large tower in the centre of the building will be of wood covered with copper; this will be surmounted by a cross, two smaller crosses being placed at either end of the roof. The cornices will be of copper.

Provision for escape in case of fire is made in the form of spiral fire towers at the rear. Access is given to these by means of iron galleries, with mosaic flooring, running the entire length of each floor, and having several doors opening on to them. The iron towers are built a few feet away from the school, but are connected to it by the galleries, so that the children can walk direct from the galleries into the towers and thus be conveyed to the playground. The building has light on four sides. The estimated cost is $140,000. Messrs. Martineau and Prenoveau, Montreal, are the contractors.

Examination for Highway Engineers

An open competitive examination for senior highway engineers has been announced by the United States Civil Service Commission, open to all male citizens of the United States, who meet the requirements. The purpose of the examination is to establish an eligible list from which vacancies will be filled in the office of Public Roads and Rural Engineering, Department of Agriculture. The positions pay from $2,000 to $4,000 per year, those obtaining a rating of 85 per cent. or over being eligible for appointments to positions carrying salaries of $3,000 or more. Applicants must be thirty years of age, be physically fit, and must have had not less than four years preliminary engineering experience or must be graduates in engineering from a recognized college. Eight years of responsible engineering experience are required, of which five years must have been in highway work. Competitors will be examined on the following subjects, which carry the relative values indicated: Education and preliminary training in engineering, 20 per cent.; responsible experience in engineering and fitness, 30 per cent.; responsible experience in highway engineering, 50 per cent.

Board of Health Order Filtration

The city of Hull and the town of Aylmer have been ordered by the Superior Board of Health of the Province of Quebec to filter their water, the supply from the Ottawa River not being considered safe. The village of Richelieu will have to construct an intercepting sewer, and the town of Drummondville have been ordered to at once filter their water.

There are 73 buildings, large and small, used for exhibition purposes at the Canadian National Exhibition, Toronto.

Details of Highway Construction

Preparing Plans on a Standard Basis—Good Advice to Municipalities — Some Interesting Cost Figures

THE State Highway Commission of Minnesota was organized to supervise and superintend the highway work throughout that state. One of its policies has been to prepare plans for bridges upon a standardized basis, and many of these bridges have already been erected. The Commission also offers suggestions to the municipalities in regard to their highway schemes and advises them upon the best methods. In the following paragraphs we extract some items of interest appearing in the Minnesota Highway Journal, the official publication of the Commission:

Good Concrete

Many inquiries are received by the highway commission in regard to the proper amount of cement to be used with pit-run gravel to make good concrete for bridges.

This question is very hard to answer accurately, because no two gravel pits are alike, and often there is a wide variation in the quality of gravel in the same pit. Good pit-run gravel should be clean, hard, free from slate or soft stones, and when separated into sand and pebbles, by screening, should yield about twice as many pebbles, by volume, as sand, the sand grading from ¼-inch size down. The pebbles should vary from ¼-inch to 1½-inch in size. Such material will make good concrete when mixed, one part of cement by volume, to four and one-half parts of pit-run gravel.

Examination of many samples of gravel from all parts of the state shows, that with few exceptions, the pit-run material contains too much sand in proportion to the pebbles. In many cases there are practically no pebbles, and frequently there are impurities in the sand, such as clay, slate, silt, vegetable matter, etc., which may make the gravel unsuitable for concrete work.

Concrete gets its strength from the mortar which binds the stones into a solid mass. If the strength of the mortar is kept constant, by using the same mix of cement to sand, the stones can be partly or wholly left without materially weakening the concrete.

In using pit-run gravel, if one part of cement is used with every two and one-half parts of sand contained in the gravel, a good concrete should result, provided there are little or no impurities. If there are impurities present, the proportion of cement should be increased. For the average pit-run, the mix should be about one part of cement to three parts of gravel, and in many cases it should be one to two and one-half, or even one to two. This will require from eight and one-half to twelve and one-half sacks of cement per cubic yard of concrete.

The proper and accurate way to make concrete is to separate the sand and pebbles by screening, and remix them with cement according to definite proportions. If there is not enough of the pebble proportion, crushed rock or screened pebbles should be shipped in. The standard mix for bridges is in the ratio of one, two and one-half, four, or one part, by volume, of cement to two and one-half parts of sand to four parts of screened gravel or crushed rock. This requires five and one-half sacks of cement per cubic yard of concrete, and with good materials, gives excellent results. The amount of sand is cut down to a minimum, thus reducing the effect of impurities which if present, are generally in the sand.

The saving in cement by using screened materials, will frequently pay for the extra cost of obtaining them. If there is any extra cost it is money well invested.

The use of screened, and if necessary, washed materials, is strongly advocated. It insures first-class results and places the making of concrete on a definite basis, instead of trusting to luck as to what the gravel will be, and what part of a specified pit will be used.

Such concrete work built under competent inspection, would be a great deal stronger than pit-run gravel concrete. It would be possible in many cases to make walls and slabs thinner, and thus affect a further saving in cost.

Reinforced Concrete Bridge Test

In order to give county and township officials an opportunity to witness the action of a concrete bridge under extreme loads the highway commission is now constructing a test bridge at the State Fair grounds to be part of the exhibit for the next fair.

A great deal of information will also be obtained for use as a basis in future designs, as an improved type for short span bridges will be tested and very careful measurements made with the load placed in various positions.

The co-operation of the Experimental Laboratory of the University of Minnesota has been obtained, and the test is expected to be one of the most complete and valuable highway bridge tests conducted up to this time.

Tests will be conducted during the entire Fair Week, and results posted on a bulletin board. Probably on the last day of the fair a great enough load will be placed on the bridge to break it down in order to determine the ultimate strength, and also the location of the weakest points in the design.

With the present high prices of steel, more concrete bridges are being built. There has been no opportunity to obtain as much data for design on this type as on steel bridges, of which there have been many built in the past and where failures have occurred due to too light construction, the information obtained has been used to make our design correct.

In the design used for superstructure of the test bridge there is about 35 per cent. less concrete than used in the ordinary slab bridge, and if it proves strong enough a big saving will result in the future designs for short bridges.

Bridge Floor Covering

With but few exceptions, all new steel bridges for which plans are furnished by the commission, are built with a concrete slab floor. All such floors should have a gravel wearing surface placed on them and the same protection should be placed on all reinforced concrete bridges. It is very important that this covering be thick enough to protect the slab from the

horses' caulks and from the mud hooks on traction engine wheels, but it is also important to prevent making it so thick that the bridge will be overloaded.

On beam span and short concrete bridges where the extra weight is not so serious, our plans call for a gravel covering 4 inches thick at the curb and 5 inches thick in the centre of the roadway, but on truss bridges the gravel should only be 2 inches thick at the sides and 4 inches thick at the centre.

It is not uncommon to find truss bridges with the gravel placed level with the top of the curb and then crowned at the centre, giving an average thickness of 9 inches instead of 3 inches.

The weight of each inch of gravel covering on the floor of a 100-foot truss span, 18-foot roadway figured at 120 pounds per cubic foot, is 8.4 tons, and where it is made 6 inches extra in thickness the overload is 50 tons.

This matter is called to the attention of county and township officials so that they will arrange to reduce the thickness of the covering where it is already excessive and prevent future overloading of the bridges.

Piling Versus Increased Depth of Abutment

In designing abutments for bridges the question often arises as to whether wood piling should be used or the abutment carried down to a greater depth so as to eliminate the piling.

If the difference is more than two feet it will be found that piling will prove cheaper in almost every case. In order to show this more clearly we will consider a typical case of a 30-foot standard plan on reinforced concrete abutments.

If piling are used the abutments will have to be 14 feet high, while if the piles are omitted and the concrete is carried down to solid bearing a height of 17 feet will be required. The higher abutments contain 25 cubic yards more concrete and 3,160 pounds more reinforcing than the 14-foot abutments, which extras would cost about $470.00.

The cost of thirty-two wood piles 20 feet long would be about $320.00.

This shows an estimated saving of $150 by the use of timber piling and in all probability the saving would be even greater, as no attention has been paid to the fact that the deeper excavation would be more expensive and therefore would increase the unit cost of the 17-foot abutment.

In addition to economy there remains to be considered the relative merits of the two structures.

The abutment on wood piling should be better in every respect, as it is almost impossible for it to be washed out or in any way injured by high water. The abutment without piling would have to go to a considerable depth below water which would make it difficult to properly place the steel in the footings and lower part of the wall.

Taking everything into consideration, the abutment with piling is in almost every way superior to the one resting merely on earth or gravel foundation.

Cost of Bridge and Fill

It is not economical to make a bridge any longer than sufficient to safely carry high-water stages, as the cost of an earth fill is much cheaper.

Take for example a bridge with the grade 14 feet above ground level; adding a 23-foot beam span approach, it would cost about $30.00 per lineal foot, including the cost of the additional pier.

A fill 14 feet deep and 24 feet wide on top with 1½ to 1 side slopes contains 23½ cubic yards, which, at 30 cents per cubic yard, would only cost $7 per lineal foot of fill or only 23½ per cent. as much as the cost of the bridge.

Color of Bridges

It is urged by the highway commission that the country and township boards adopt white as the color for their bridges.

The main advantages are that the bridges show up better at night, and repainting is not so likely to be neglected, as there is a great contrast between the paint color and rust, while with a red or a dark paint there is nothing to call attention to the fact that the bridge needs repainting.

It is necessary that the white paint be specified on the plans so that the shop coat can be of a light color, otherwise the white field coat will be darkened too much.

We will keep a list of such counties and townships notifying us that they have adopted this color and will put this requirement on the plans when furnished.

Floors

The department is frequently requested to inspect old bridges to determine whether it is feasible to replace a wood floor, which is costing considerable money to maintain, with a concrete floor. In a majority of cases the old bridge is found to be dangerous for traction engines with the wood floor in place, and substituting a concrete floor would overload the bridge so as to make it unsafe even for a wagon load.

As a typical case, take a 60-ton truss with a 16-foot roadway; the weight of the plank floor is 3.6 tons. This shows that it takes a much stronger bridge to carry a concrete floor.

We find that the cost of about three wood floors will pay for a concrete floor, and also for extra steel in the bridge to make it safe for the extra load. In other words, after the original wood floor has been replaced twice, on a light truss, the expense is as much as it would have been to build a concrete floor bridge, and any further expense is a waste of money

Rougemont Waterworks

On instructions from the municipality of Rougemont, P. Q., Mr. Fabius Riel, engineer, of Montreal, has drawn plans for a waterworks scheme. The water comes from the mountains in the district and is collected in a creek. It is proposed to build a concrete dam 11 feet high by 40 feet long, and also a concrete reservoir of 60,000 gallons capacity, into which the water will run by gravity. From here a 6-inch cast iron main, of 14,200 feet, will convey the water to the municipality, the pipe for the cross roads being 4 in.; from the reservoir to the municipality there is a drop of 179 feet. House connections of lead pipe will be made.

Modern Building Materials

The Philip Carey Company, of Lockland, Cincinnati, Ohio, have issued a little booklet for the information of prospective builders, describing and illustrating their various lines of waterproofing and weatherproofing materials. These include "Asfaltslate" shingles, Carey Flexible Cement Roofing and Carey Rubber Roofings, also "Ceil-Board" for walls and ceilings, and waterproofing materials for different other purposes. Some space is also given to explaining methods of application.

Fireproof Building Construction

Properties of Various Materials Change Greatly with Temperature — A Few Precautionary Suggestions

THE term "fireproof," as applied to building construction, is not a well-defined term in the public mind. To be absolutely fireproof a building must be made entirely of incombustible materials. Materials which are affected by heat or water must be eliminated or protected by those not so affected. Very few buildings can be classed as absolutely fireproof. The majority are, to be exact, merely slow-burning, but are popularly regarded as possessing fireproof qualities. The choice and character of the fireproof materials to be employed in a building depend on the use to which the building is to be placed, the nature of the contents, and the interests of the owners.

A building should be designed, built, and finished in accord with the purpose for which it is to be used. One containing but little inflammable material need not be as thoroughly fireproof as one designed for the storage of valuable goods or the protection of life in case of fire. The height of a building determines to a large extent, also, whether it should be fireproof or not. Extra high structures impose difficulties in the way of fighting fires. The area of a building also is a determining factor, although interior walls and partitions practically break it up into a number of smaller buildings. Besides the design and equipment, the problems of construction are important in determining the character of a fireproof building.

There are essentially only two kinds of buildings which can be made to fulfil the requirements—reinforced concrete and fireproof steel—and it is quite impossible to lay down a general law and say that one is better than the other and should be used exclusively. Each has its particular adaptability, and it is only by careful study of each particular case that the correct choice can be made.

Concrete More Available.

The cost is, in many cases, the deciding factor. Local conditions influence cost so much that no specific statements can be made in this regard. Often reinforced concrete will be cheaper than steel construction, due to the availability, in general, of the materials of which concrete is composed. Sand and gravel are usually plentiful and cement is easily obtained. On the other hand, structural steel can be procured from the mills only, and must be fabricated in the structural shops. The availability of concreting materials also allows work to start when the design is completed.

The fact that expenditure on concrete buildings is almost entirely local is an important feature. Both labor and materials are obtained near the vicinity of the construction, while for steel building the manufacture and fabrication of the steel is performed far from the scene of erection.

Maintenance and insurance must be considered. Reinforced concrete involves the least expense in upkeep. The question of permanency is as yet an open problem, since both types of construction are comparatively recent developments.

A more or less minor consideration is the storey height desired. Concrete construction requires deeper beams than steel, which may mean that the height for the same head room may have to be increased.

All materials of construction are more or less seriously affected by high temperatures. The San Francisco fire showed that all materials—brick, terra cotta, granite, concrete—failed when directly exposed to the fire for any length of time.

The temperatures reached in fires are from 1,600 degrees F. to 1,800, or even 2,000 degrees. These temperatures are liable to affect almost any constructional material. An ideal fireproof material should possess the following properties: (1) Incombustibility; (2) ability to stand molecular change under heat; (3) poor conductor of heat; (4) capable of carrying a structural load. In the following paragraphs are given some characteristics of fireproof materials:

Brick.

Common brickwork, when of good quality, will stand exposure to heat for a considerable time, but in a severe fire the heated side of a wall expands, and the bricks crack, shell, and sometimes melt. Thick walls are less affected than thin walls, and hard-burned bricks are superior to soft or under-burned ones. As a fireproof material for outside walls, experience has indicated that brick is superior to any other wall material.

Stone.

Stone is not recommended for fireproof buildings, as it does not stand the action of severe heat, especially limestone, marble, and granite.

Terra Cotta.

Terra cotta is incombustible, a reasonably poor conductor of heat, and undergoes no molecular change when heated, and on this account is a good fireproofing material. Terra cotta is made in three varieties—dense, porous, and semi-porous. The dense tile is made of pure clay, burned at a high temperature. When used for fireproofing, care must be taken that the tiles are free from cracks, sound, and hard burned. The porous variety has 25 per cent. or more sawdust mixed with the clay, so that when burned the clay is porous. It ranks very high in heat-resistant qualities, and when properly made will not crack or break from unequal heating or from being suddenly cooled with water when in a heated condition. Semi-porous terra cotta is made with coal dust in the clay before burning. The non-conducting properties of terra cotta are sometimes a source of trouble in a fire, as it has been observed that the outside face becomes red hot, while the inner webs remain comparatively cool. The temperature stresses thus set up have sometimes caused the outer face to sheer off.

Concrete.

Concrete has of late years become very popular as a fireproofing material. It does not, so nearly as terra cotta, fulfil the requirements of an ideal material, but its deficiencies are more than made up by the manner in which it may be applied. Stone concrete is affected, under the action of heat, in much the same way as brickwork, the heated surface expanding, and as con-

crete is a poor conductor, the other surface remains cool and cracks or warps. The strength and texture is also affected by heat, and concrete will burn off to a depth of 1½ inches. Trap rock, broken brick, or cinders make the best aggregates from a fire-resisting standpoint. Blast furnace slag makes a good material. Cinder concrete possesses most excellent fireproof characteristics, but its strength is more or less doubtful, so that as a load-bearing material it is not recommended.

Mortars and Plasters.

Mortars and plasters will stand the heat up to a certain degree, after which they are affected in one way or another, depending on the composition and on the way in which they are used. Cement mortar is generally preferred for resisting fire. Lime plaster can stand the heat to a high degree, but streams of water are liable to wash it away. Some of the patent plasters will stand the effects of fire and water longer than the common mortars.

Iron and Steel.

Iron and steel, although non-combustible, are not fire-resistant. They begin to soften at quite moderate temperatures, even as low as 1,200 degrees F. Hence loaded columns and beams are subject to failure in the temperatures found in ordinary fires. No building in which unprotected iron or steel is used can be considered fireproof. Cast iron is preferable to steel from a heat-resisting point of view. To render steel or iron columns and beams fireproof requires a protection of some material, such as brick, tile, or concrete.

Miscellaneous.

Besides the above-mentioned structural materials used in fireproof construction there are others that are of more or less importance, such as sheet metal, asbestos, and asbestos-covered products, treated woods, wire glass, and fireproof paints.

Fireproofing of Columns.

The adequate protection of columns is the most important problem of fireproofing. If a floor or beam fails, the damage is usually local; but if a column fails, more serious trouble is likely to occur.

Protecting columns with wire and plaster is not very effective, as under the action of heat the plaster calcines and washes away in a stream of water. Two layers reduce this difficulty to a large extent. The use of terra cotta is very satisfactory, care being taken to ensure that it is firmly held in place. Red brick set in Portland cement is the best protection for columns. It is not generally used, however, on account of its cost and weight.

Concrete is considered almost as effective as good brickwork when properly applied. Most efficient construction is obtained by using cinder concrete, a coat of liquid cement being first applied to the metal with a brush. Cement concrete is better than stone concrete. During recent years a new method of protecting steel by means of a cement gun has been developed. This consists essentially of two superimposed tanks forming two compartments, from the bottom of which a dry mixture of cement and sand is ejected by compressed air through a hose line with a nozzle at the end. To this nozzle a smaller hose deilvers a supply of water under pressure, which is applied to the dry constituents just before emerging from the nozzle. The mortar, issuing in the form of a spray, shoots out from the nozzle with considerable force and impinges on the surface of the steel work. Inaccessible corners are readily protected without the use of forms. Tests show that "gunnite" is superior in tensile and compressive strength, permeability, absorbtion, porosity, and adhesion to hand-made products of the same kind.

Fireproof Floor Construction.

In the study of fireproof materials by far the greatest attention has been given to floor construction, and a large number of types have been developed. It is needless to say that a fireproof floor must be made of incombustible materials, and must resist as far as possible the transmission of heat so as to afford the protection of the metal encased in it. The material should not disintegrate under heat or wash away under the action of water.

The brick arch was one of the earliest attempts at fireproof floor construction. Brick is sprung between the lower flanges of I-beams, the space above the brickwork being filled with light concrete to the floor level.

The corrugated iron arch was another early form, in which a sheet of corrugated iron was sprung between I-beams, with concrete filling. In first-class fireproof construction the bottom flanges should be protected by terra cotta skew-backs.

Tile floors are quite fireproof. Many different systems have been devised for these, some involving end construction, some side construction, and some a combination form.

Concrete floors are used considerably in fireproof buildings, either flat slab or segmental arch types. The slabs consist of a concrete containing steel, which takes all the tensile stress. The steel is, of necessity, placed near the lower surface of the slabs. In order that the steel may not be softened by the heat in a fire, it must be covered with a certain amount of material, which adds nothing to the strength of the slabs.

In the segmental concrete arch all the concrete is in bearing, and the floor does not rely for its strength on metal close to the surface. For this reason this type is more desirable as a fire-resisting floor than the flat slab.

There are many patented systems of concrete floorings, but the distinguishing features are generally in the type of reinforcement.

Fireproof floors must be made water-tight, so that no water will leak through to the under side.

Beams and Girders.

No form of floor construction can be considered thoroughly fireproof unless it includes a protection of the lower flanges of all steel beams and girders, or provides for the protection of all steel used in its construction or support. When beams support the floor directly they are, as a rule, protected by the material of which the floor is composed. Tile, cement or plaster may be employed. When concrete is used for this purpose, some kind of wire fabric should be provided to hold it in place. The protection of girders should be built up independently of the floors, so that if the floor fails the girder will not be exposed. Concrete beams and girders should have 1½ inches outside any metal reinforcement.

Partitions.

As a rule ,the partitions in fireproof buildings are not required to carry any load, but are to act merely to divide the floor into rooms and for the purpose of confining a fire to the compartment where it originates. Partitions must resist passage of flames, be non-conductors of heat, and be unaffected by water. In the past a common partition has consisted of metal lath, supported on light channels and covered with a coat of hard plaster. In a fire the plaster quickly disintegrates and allows the fire to break through. Portland cement

plaster is more efficient, but must be fairly thick to effect its purpose.

Terra cotta tile is often built up to form a partition. Concrete partitions, while they possibly could be constructed to be fireproof, are too expensive. In case a rearrangement is desired, they are objectionable.

Interior Finish and Fittings.

The interior finish, including doors, door-jambs, window-frames, sashes, bases, and trims, must be made of incombustible materials to render a building fireproof.

The effort to make the interior of buildings fireproof has resulted in the production of metal-covered wood, and in doors, sashes, frames, trim, and moldings of hollow steel or other metal. Hollow metal trim is very efficient in resisting fire and is handsome in appearance.

Stairs.

Iron stairs, as usually installed in fireproof buildings, are not fireproof unless protected. Slate and marble treads and platforms, unless supported underneath, should not be employed. Fireproof stairs can be made of clay tiles, bricks, or reinforced concrete.

Exterior Walls.

The nature of the outside walls is determined largely by appearance. Brick is the best material from a fireproof point of view. Stone is a poor resister of fire. Concrete walls are troublesome on account of the form work involved.

Protection from Outside Hazard.

To be thoroughly protected against the outside danger of fire, buildings should have means of closing all outside openings against fire. The usual devices for this purpore are tin-covered wooden shutters, steel shutters or doors, and metal frames and sash glazed with wire glass.

Tin-covered wooden shutters, when properly constructed, make the most effective window protection. The wood must not contain resin or moisture that, under the action of heat, may force the tin off, nor must the tin be fastened by solder. Doors of this type are used on inside openings, hung on inclined tracks, so as to close automatically. When necessary to keep them open under ordinary conditions a fusible link is provided.

Steel shutters or doors use a sheet of steel braced by angle irons on the back. These doors are made to swing on hinges, slide on tracks, or roll vertically. This type, under the action of heat, warps very readily, and transmits a great deal of heat.

Metal-covered sashes with provision for wire glass are quite satisfactory for protecting from fire and do not present the objectionable appearance of the previously described types. They do not hide a fire, and are more easily opened when it is necessary to reach a fire. The sashes may be stationary, pivoted vertically or horizontally, hinged or double hung with weights. For hotels and offices a type is often used which has two sashes glazed with wire glass and closing automatically in case of fire, and a third sash glazed with clear glass, thus providing all the advantages of an ordinary window with the additional advantages of fire protection and better diffusion of light. When the contents of a building are inflammable and the exposure severe, two thicknesses of wire glass should be used, with a ventilated air space between the lights.

Extinguishing Devices.

Water curtains are really sprinkler systems placed at the edge of the cornice of the roof so as to throw a curtain of water along the front of a building and thus prevent fire from issuing from the windows to structures across the street. The objection is that the water, before going far, is changed to spray. Water curtains over each window might be better.

There are many devices for detecting and checking fires in use in office ouildings and warehouses when the fittings or contents are combustible. Automatic alarms, sprinklers, and hose reels are the more common of these.

Automatic Alarms.

Many electric alarm appliances are on the market. These operate by sensitive thermostatic devices, recording a change in temperature of 35 degrees or so.

Automatic Sprinklers.

These employ an arrangement of pipes, with valves at frequent intervals, closed by fusible plugs, which melt in case of fire, so that water is sprayed on the contents and trimmings of the building. This system is extremely satisfactory, as the water is more evenly applied than from a hose, and the source is directly above a fire. The water supply is sufficient to drench the inflammable material beyond a point of ignition. In cases when the water in the pipes is liable to freeze, air under pressure is kept in the pipes, which is released by the opening of a head valve under heat. This release of pressure opens the valve in the main supply line, allowing water to flow through the sprinkler pipes.

Hose Reels.

In places where sprinkler systems are unsuitable, hose reels, connected to a stand-pipe on the roof, are often located.

Good Construction Necessary.

In all fireproof buildings care must be taken to insure proper materials, carefully inspected. Numerous fires have shown that in many so-called fireproof buildings workmanship and material were skimped. Architects are prone to pass poor work to avoid delays in completing the job, and contractors take advantage of this. It is far worse to call a building fireproof when it is poorly constructed than to erect a non-fireproof one under its true colors.

M. J. Stack & Co. Get Contract

A contract for the construction of underground conduits for the city of Montreal has been let to M. J. Stack and Company, Montreal. The conduits will be on St. Lawrence Boulevard from Sherbrooke to Craig Streets and are in addition to other conduits constructed and contemplated in the main thoroughfares of the city. The price is $57,334, and is the lowest of the tenders sent in. The plans provide for single and double manholes.

15 Million Gallon Pump

The Algoma Steel Corporation, Limited, of Sault Ste. Marie, Ont., have awarded a contract to the Turbine Equipment Company, to supply one 15 million gallon De Laval single stage, double suction, centrifugal pump, direct-connected to one 550 h.p. Canadian Westinghouse motor; also one 3 million gallon unit, direct-connected to a 125 h.p. motor, and two 1 million gallon units to be direct-connected to 40 h.p. motors. These are required for the new furnace which is being installed.

Separate Sludge Digestion in Imhoff Tank

Operation Improved by Providing Auxiliary Sludge Chamber with Two Pumps to Secure Mixing of Fresh and Decomposed Sludge

By Dr. Karl Imhoff*

THE most modern and the most widely-used methods of sewage treatment show an unmistakable tendency to keep the sewage as fresh as possible, to remove the settled sludge from the settling chamber as rapidly as possible, and to cause this sludge subsequently to undergo a process of anaerobic decomposition in a separate chamber. Imhoff tanks are included in this category. The characteristic of an Imhoff tank is that it is composed of a sludge chamber situated under a settling chamber and so connected with the settling chamber by means of a slot as to permit the settling sludge to slide by gravity from the latter into the former, but so as to prevent any flow of sewage through the sludge chamber.

Objection has sometimes been made to Imhoff tanks on the ground that they necessitate two-storied construction, with its attendant difficulties and expense; and attempts have frequently been made to secure the advantages of Imhoff tanks by placing a sedimentation chamber and a sludge-digestion chamber side by side and then pumping the sludge from the former to the latter as a substitute for the gravity flow in Imhoff tanks. However, many difficulties have developed in the course of these attempts, and it is only recently that these difficulties have been obviated.

Separate Sludge Digestion.

In the following discussion apparatus will be described in which the settling chamber and the sludge-digestion chamber are situated side by side, and in which it has been found possible both to keep the sewage fresh and to digest the sludge satisfactorily. All apparatus herein described has been constructed and operated on a practical basis in large municipal sewage plants.

The difficulties which have developed in connection with separate sludge digestion are twofold. They relate to the settling chamber and also to the sludge chamber. The problem in connection with the settling chamber is to remove the sludge from it so frequently and so completely as to insure the maintenance of the sewage in a fresh condition. The older type of plant, in which it is necessary to pump out the total water content of the tank each time sludge is removed, will not be discussed here, as this type of plant is not practical. There is only one other form of plant, and in this form the sludge is removed from the tank without discharging the supernatant liquid. The invert of the sedimentation chamber in designs of this kind must be divided into one or more sumps and a sludge-discharge pipe inserted for each sump, so that its lower end reaches to the lowest end of the sump. In the operation of plants of this kind it has developed that the sludge cannot all be removed, but that a considerable portion always remains sticking to the walls. In addition the inevitable funneling of the sludge in the sump and the consequent discharge of water with the sludge unnecessarily increase the water content of the latter. The residue of sludge which remains in the sedimentation chamber decomposes, gasifies, floats to the surface, and may thus escape with the effluent.

In the accompanying drawing these difficulties have been avoided by the addition of a hood above each sludge sump. The presence of this hood makes it unnecessary to remove all of the sludge at each operation. Even if the remaining sludge should become septic and float it would be confined to the hood and not endanger the effluent. In effect, it would rise to the surface inside the hood, sooner or later give up its gases, and finally sink again, to be removed with the next sludge discharge. Inasmuch as the sludge is never completely removed, it is impossible for water to break through and escape with the discharging sludge.

In addition to this device, which makes it possible to obtain sludge of relatively low moisture content and simultaneously to keep the sewage fresh, there are also a number of other new features included in the drawing. The tank is cylindrical and its invert is conical. Such a design permits the same slope at all points of the invert and causes the sludge to slide uniformly toward the lowest point. Statically, also, this form of tank is the best. It makes possible the use of thinner reinforced concrete walls than any other design, since it is exactly adapted to receive the stresses produced by the upward pressure of ground water and by the radial pressure of the liquid contents.

Flow Horizontal.

The direction of sewage flow in the tank is horizontal, and not downward and upward, as has hitherto been usual with circular tanks. The downward and upward direction of flow has been found to be inferior from the standpoint of percentage removal of settleable solids. Nor does the sewage flow from centre to circumference as in the past. It flows from one side of the tank to the other, so as to produce a longer flow line and at the same time to eliminate a considerable portion of the excessively long circumferential effluent channel. This form of tank therefore approaches most nearly an ideal design from the three standpoints of statics, sewage sedimentation, and sludge removal. The drawing shows two tanks combined as one.

The decomposition of sewage sludge in separate chambers was first believed possible in shallow, flat-bottomed tanks. It was thought that it would simply be necessary to pump the sludge into these tanks and allow it to remain until sufficiently decomposed. All attempts of this kind have, so far as I am aware, failed. The sludge in these tanks produces unpleasant odors and takes a long time to decompose to anything like a condition in which it can be dried without nuisance.

A properly designed sludge-digestion plant should be one in which the sludge takes only a few months to decompose to a condition in which it dries easily and without producing a nuisance. Neither should any foul odors be produced in such a plant during the process of decomposition. These requirements have been satisfied in Imhoff tanks, and it seems logical, therefore, to imitate artificially in the separate digestion process the conditions obtaining in an Imhoff tank.

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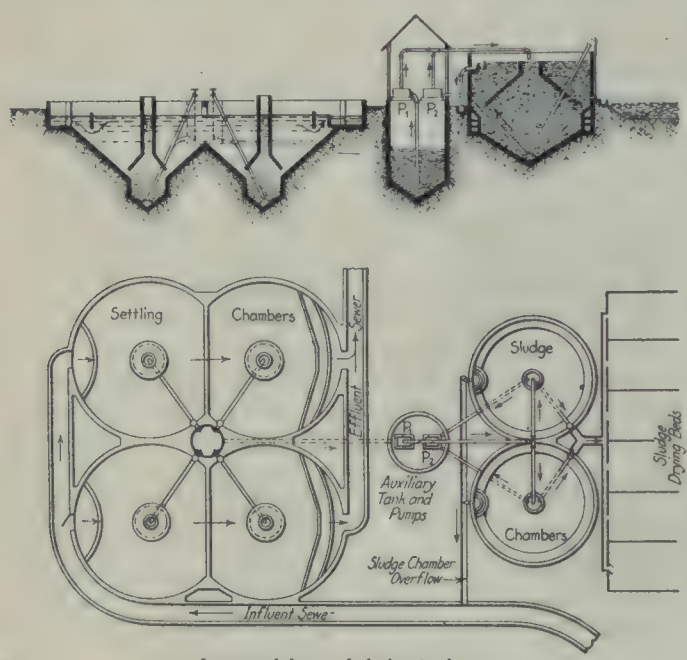
The design shown in the drawing is the result of a successful attempt to imitate these conditions.

Promote Growth of Organisms.

In order to achieve odorless decomposition it is necessary to promote the growth of the proper organisms and to maintain the conditions necessary for their existence. With this in mind it seems logical to feed the sludge that is properly decomposing, and to "inoculate" the fresh sludge with the proper organisms as soon as it arrives. This inoculation is necessary so that the fresh sludge may not have an opportunity of entering into improper decomposition—for example, acid decomposition. Both of these conditions may be fulfilled by the same device. In short, it is merely necessary to mix the fresh and decomposed sludge in accordance with certain rules. Such mixing may be most simply done in closed pipes.

In the drawing it will be seen that the fresh sludge flows by gravity from the settling chamber to an auxiliary sludge chamber. This chamber is provided with a pump, P_1. It will be observed, also, that a pipe leads from the bottom of the sludge digestion tank to a second pump, P_2, also located above the auxiliary



Improved form of sludge tank.

chamber. In operation the two pumps simultaneously force both fresh and decomposed sludge into a common sludge pipe. This manner of operation results in immediate mixture of fresh and decomposed sludge in any desired proportion and in the discharge of this mixture into the digestion chamber. Further mixing occurs in the digestion chamber itself by means of the rising gas bubbles. The small gas bubbles which develop as a result of the decomposition process remain sticking in part to the sludge particles and by increasing in size progressively reduce the mass specific gravity of the combined sludge particle and gas bubble until it is less than that of water. At this time, of course, the two rise to the surface of the tank.

If the action taking place on the inside of the digestion chamber could be observed it would be seen that large and small particles of sludge are continuously rising to the surface of the tank, there giving up their gas bubbles, and, once more heavier than water, sinking back to the sludge layer at the bottom of the tank. This natural mixing, however, is insufficient. If it alone be depended upon it will be found that in a short time a scum layer will develop and will grow thicker and thicker. When, after this begins to take place, gas-laden sludge particles rise as described, they are not able to release themselves from their gas bubbles because of this impenetrable mat on the surface, but instead become imprisoned in it. Little motion or mixing takes place in this scum layer, and for this reason it will be found that the decomposition taking place in the scum layer will be relatively feeble, may, indeed, be an undesirable or nuisance-producing kind of decomposition. This evil may be artificially avoided by constructing in the digestion chamber a partition or apron which operates in a similar manner to the partition walls in Imhoff tanks. With this apron in place the gas bubbles are deflected to a definite point or points in the tank surface. In the drawing this point is shown as the middle of the tank. In consequence of this provision there will be no rising gas bubbles at any other part of the tank surface, and any floating sludge there, not being continually buoyed up afresh by rising gas bubbles, will gradually become heavier than water and sink to the bottom. In the middle of the tank, however, to which point all of the gas bubbles are being deflected, the combined stirring action of the gas bubbles is so strong as continuously to break up the scum layer.

It seems logical, also, to make this part of the tank surface the part at which the fresh sludge is introduced, because at this point exists the best opportunity for the fresh sludge to become mixed most quickly and most uniformly with the contents of the tank.

Uniform Temperature Desirable.

Since the decomposition of the sludge depends upon living organisms it is necessary to maintain the temperature as uniform as possible. In Imhoff tanks this occurs naturally by virtue of the depth of the tank and because of the fact that the sewage which flows through the settling chamber above the sludge chamber is fairly uniformly warm. Separate sludge digestion chambers built above ground may develop difficulties, because it may not be possible without artificial aid to prevent harmful fluctuations of temperature. Artificial means may, therefore, in this case be of advantage. In the drawing are shown circumferential conduits on the inside of the tank. These may be operated either with warm water supplied from a central heating plant or simply with sewage.

Cost of Waste Disposal

Figures tell pointed stories when they can be made to speak. A great deal has been said concerning the quantity of wood wasted in milling operations, in the form of sawdust, edgings, blocks, and scraps of various kinds, and the public is fairly familiar with this subject; but investigations have now been made which claim to show what it costs to dispose of this waste. It is asserted that every thousand feet of lumber sawed in the United States is called upon to pay from eleven to twenty-two cents to meet the cost of getting rid of waste material. The average figures show a cost of seventeen cents per thousand feet, but in some mills it runs as high as twenty-two cents and in others as low as eleven. The yearly total is about $6,000,000 for the whole United States.

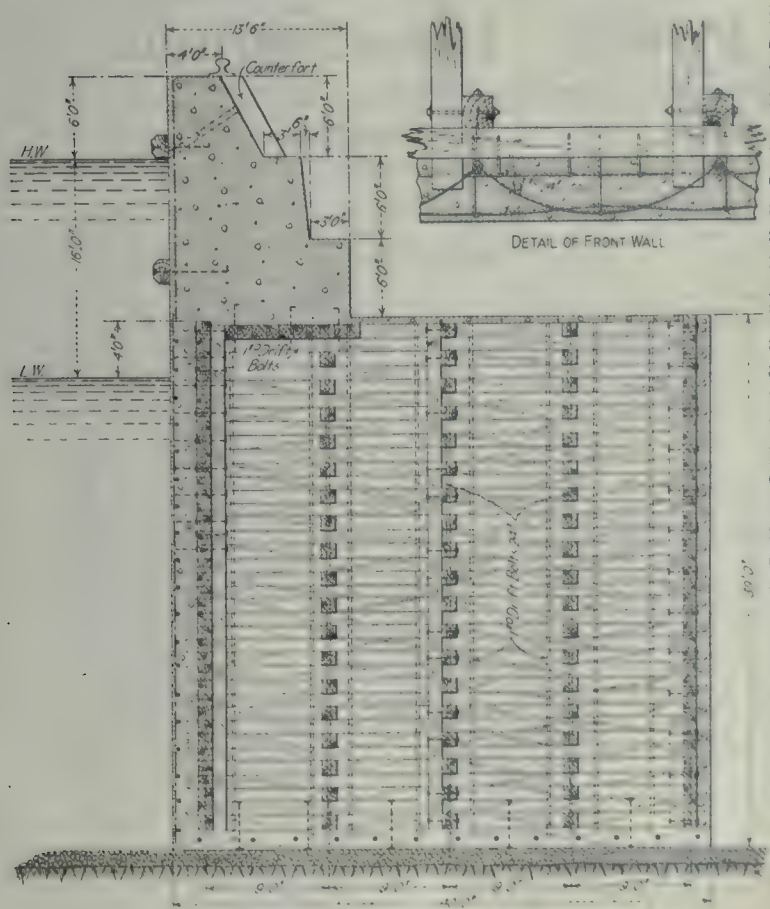
These figures are backed by the authority of the Forest Products Laboratory at Madison, Wis., and it appears that this investigation was the first ever conducted in a thorough manner to determine what it costs to burn the refuse matter at saw mills. Burning is the cheapest method of disposal that has been devised.

The Government Dry Dock at Vancouver

Interesting Details of Construction Work Described and Illustrated — A Large Grain Elevator Being Built Adjoining the Wharf

WITH further reference to the government dry dock and elevator at Vancouver, to which reference was made in a recent issue of the Contract Record, the following article by R. Mackay Fripp, in a current issue of the Engineering Record, describes a number of interesting details of construction work:

Inclosing 5½ acres of ground and providing at low water a depth of 35 feet, a wharf the outer wall of which is made up of timber and concrete cribs has recently been built for the Dominion Government at Vancouver, B. C. After the rock excavation for these cribs had been made, the bottom was covered with two feet of broken stone, leveled with an I-beam drag operated from a scow. The cribs sunk on this foundation showed a maximum variation in line of only three inches and in grade of only two inches. The cribs were built to a height of 10 feet on ways, launched and completed in the water. A floating concrete plant, with a tower and chute, was used in their construction. The water space between the walls has been filled, leveled and rendered immediately available for trackage. The depth of water at low tide is 35 feet. The range of tide is 16 feet. East and west wings or bulkheads are built at the shore and to retain the filling, which is carried up to the tracks of the Canadian Pacific Railway. A grain elevator with 1,250,000 bushels capacity is in course of construction adjoining the shore end of the wharf.



Showing construction of crib.

Operations were commenced by excavating the stiff heavy clay and boulders which overlay the rock bottom, a dipper dredge being used. To deal with the rock a drill scow, 100 x 30 feet, was built and equipped with drill towers, the drills being 34 and 57 feet in length. Additional weight was given to them by a 4500-lb. backing. The rock is of a conglomerate nature, closely resembling a coarse concrete of water-worn granite stones and cement and makes very hard drilling, the stones constantly breaking out from the matrix and filling up the holes, which, on this account, sometimes had to be drilled two or three times before they could be charged. The rock was taken out in two and in some places three lifts, depending on the depth; but not more than 12 feet was taken out in any one lift, as it was found impossible to keep the holes jetted clean enough to allow the drills to work freely at a greater depth. Holes were charged with a hollow-tube pipe with a plunger running through it, the charges being fired by a battery. Single holes were sometimes fired, but a whole range of 90 feet in length by 12 feet deep and 5 feet wide was usually discharged at one time, yielding, roughly, about 200 cubic yards at every shot.

Drill Scow Employed

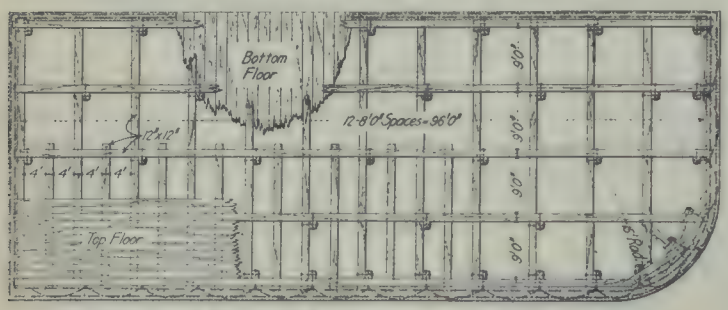
The drill scow, which was the first of its type used in these waters, was set on spuds at each corner, and each spud was worked by a separate engine. As the tide rises and falls about one-tenth of a foot every five minutes, the spuds were constantly changed.

After completing the excavation the bed upon which the cribs rest was covered with a 2-foot layer of broken stone. This was at first leveled by taking soundings with leads, but as the leads usually fell or slid off projecting stones, these projections above the first crib placed upon sounded levels had to be raised. A new and novel method was then adopted. An I-beam was attached to a bridge on a scow and cables secured to the back of the scow were passed beneath and fastened to the I-beam, which was then dropped to the grade and drawn backward and forward, after the manner of a barrow, until the bottom was rendered perfectly level. The effectiveness of this method is demonstrated by the fact that the greatest variation in the vertical joints of the western line of cribs did not exceed 3 inches; on the eastern line it was only one-half inch, and the greatest variation in the levels of the tops of the cribs was only two inches.

About 60 feet from the north, or outer, end of the wharf the rock bottom dipped or ran out. It was therefore necessary to excavate to the rock and to fill and pack this space with stone up to the grade. At this point only has there been any settlement whatever, one crib moving outward at the top 2 inches and another 3 inches. This settlement, however, occurred during the process of backfilling, when the load was constantly changing; but all settlement ceased when the backfilling was complete and the load became constant.

The construction of the cribs is as follows: A

bottom platform was built of 12 x 18-in. fir timbers drifted together with 24-in. drifts at 3-ft. centres. A first course of 12 x 12-in. timbers was drifted to this bottom platform with 24-in. drifts at 3-ft. centres and machine bolts every 5 feet. The remainder of the timbers were drifted with 24-in. drift bolts. Vertical posts were placed at every intersection of longitudinals and cross-ties on the face of the crib and at every alternate intersection in the interior and the back of the crib. These posts were fastened to the longitudinal washers. On the face of the crib these bolts were eye-shaped, the eye acting as a reinforcement. Cross-ties at 8-foot centres extended one foot through the face and six inches through the back of the crib. Fillers were placed between the cross-ties between the longitudinals, thus forming a solid wall.



CONCRETE-INCASED CRIBS BUILT WITH ROUND CORNERS AT ANGLES OF WHARF

The longitudinals were set at 9-foot centres and dovetailed 6 inches through the ends of the cribs. An extra cross-tie placed on the top of the crib made 4-ft. centres for the 12 x 12-in. decking drifted on to these timbers to serve as a foundation for the mass wall.

For launching the cribs, ways were constructed by driving piles at 10-ft. centres longitudinally and 8-ft. centres transversely. These were capped with 12 x 12-in. caps; the stringers were of the same dimension. The ways were 300 feet in length, 100 feet wide and given a 6.5 per cent. grade. The outer ends of the ways were one foot below low-water mark.

The cribs were built to a height of 10 feet on a cradle placed at the back of the ways, which were furnished with hauling gear for launching the cribs. The cradle was capable of handling a crib 107 feet in length. The cribs, after being thoroughly calked and sheathed with concrete, were brought to an even bed by ballast, and when launched drew a little more than 4 ft. 6 ins. No difficulty was experienced in launching any of the cribs.

Concrete for sheathing was a 1:3:4 mix. All concreting was done by a floating mixer with a tower and the spouting system, the spouter being used direct on the mass walls. For the sheathing the spout discharged into a hopper and the concrete was distributed thence by buggies.

Material for the backfill, a mixture of sand and clay, was obtained by dredging at various points of the harbor, being clammed into flat scows and reclammed over the wall. The material, of which there was about 400,000 cubic yards, was leveled and kept back from the walls by means of a centrifugal pump with a 10-inch suction and an 8-inch discharge, and was able to handle the dirt to within 6 feet of grade in the centre of the wharf. The fill between the back of the wharf and the Canadian Pacific Railway track was made by cars on tracks, the clamshells discharging into a bunker, beneath which the cars were spotted.

Storage for Water Power Development

A Unique Scheme for Providing an Equalizing Basin with Pumps to Return Water to the River—Features of Construction

An essential feature of any water power development is that the flow must be constant from season to season. In rivers where the cut-off is subject to wide variation, provision must be made whereby the excess water of wet seasons may be utilized to supply a lack of water druring dry seasons. This involves the use of a storage or equalizing basin of sufficient capacity to maintain at all times the desired flow. In many cases a storage reservoir must be able to provide for a succession of dry years.

A unique scheme of this kind is being developed in the State of Idaho, U.S.A., by the Utah Power & Light Company, in connection with their power and irrigation schemes. The special features of this project are the utilization as a storage basin, of a large lake, the capacity of which is very great relative to the yearly flow of the river, and also the use of pumps for returning the water into the river to obviate the necessity of building expensive gravity works. The power for this pumping station is in the form of electrical energy developed in part by the water which the pumps supply. In constructing the plant, local topography imposed many constructional problems of interest.

Location of Plant

The accompanying map illustrates the situation. The Bear River has on its course four hydro-electric power developments, besides which it supplies a large irrigation scheme. The maximum capacity of the power houses, 67,500 kw., utilizes a total head of 865 feet. The intention is to employ Bear Lake as the equalizer for this river, preventing a shortage of water during the dry seasons for either the power house or irrigation channels. Bear Lake is a deep body of water, about 20 miles long and 8 miles wide, with an available storage capacity of 1,300,000 acre-feet. The shores of the lake are steep, so that the high water and low water areas are practically the same. To the north is a swamp and a very small and shallow lake, known as Mud Lake, the two being separated by a very narrow sand bar or "causeway." At present there are two inlet channels connecting the river to Mud Lake, of such capacity that all flood water can be diverted into them.

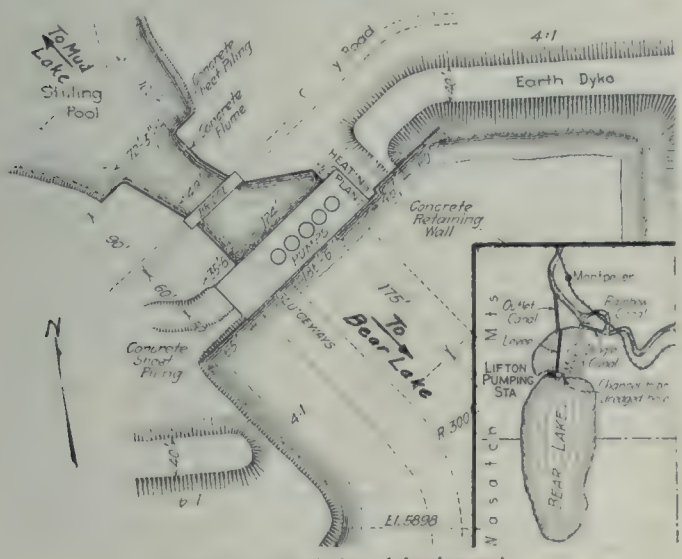
The river, near Bear Lake, has a very small slope, the fall in thirty miles being but 40 feet below normal lake level. This means that to get an outlet canal from the storage basin to the river with a large fall would involve a long cutting, besides imposing great difficulties due to the nature of the ground. The scheme that has been developed, therefore, is the building of an outlet channel from Bear Lake as far down as can be dug by dredging alone. The junction of this canal with the river is 14 miles north of the

lake and its outlet is but 8 feet below the lake's full level. It is possible to draw the lake almost down by gravity through the canal, but as the river drops the flow decreases constantly and for this reason the pumping plant was projected to make the desired storage capacity available and also to maintain the canal's full rate of flow at all lake stages.

Provision for Large Draw-down

Data covering any succession of dry years recorded shows that a 12-foot draw-down would equalize the river flow, but a 21-foot draw-down is arranged for to cover any errors in the records and to equalize other streams than the Bear River itself. By using this extra large conservation capacity, more water will be available for irrigation which is extensively carried on in the Bear Rixer drainage area. More water will be on hand than if the storage was arranged to cover only an average yearly flow.

The pumping house is located on the causeway between the two lakes. An intake channel will be dredged from Bear Lake to the pumping plant. It is expected that wave action will fill this up to a large extent, but as the expense of building a permanent



General and detail plan of development.

work would be prohibitive it was decided to dredge an extra large channel which can be maintained by dredging from time to time as required. The bar on which the plant is located is very low and flat and the ice sometimes piles up to a height of 10 feet. To avoid any trouble on this account the pumping station is located well back from the shore line and at an angle to the intake channel so that no ice will gather at the station itself.

The maximum capacity of the pumping station is 1,500 second-feet at a 20-foot head, developed through five vertical shaft units of 300 second-feet capacity each. Variable speed motors will be employed and two types of impellers are used to provide the most efficient operation at both high and low heads. So far as known, these pumps posses the largest rate of discharge against this head—about 194,000,000 gallons per day against 16-foot head at 77 r.p.m.

Details of Construction

The pump house is being constructed of a concrete mat supported on piles since the soil is of a quick sand nature. A large open timber caisson, 140 ft. x 62½ ft., was sunk to a depth of 43 ft. This caisson is one of the largest of its kind. It contains about 800,000 feet of timber and 120 tons of steel rods and fastenings. Considerable difficulty was experienced in sinking it, due, in the first place, to the firmness of the undisturbed sand, requiring hand excavation, and then by the flow of sand due to the disturbance caused by excavation. Out flows of gas from the soil in the caisson gave trouble. For long periods the gas blew out under pressure. In spite of this, however, fairly rapid progress was made. A foundation of pile groups was employed, sunk to a depth of 35 feet, that had to be jetted down on account of the hard nature of the sand. The concrete mat is 8 feet thick, engaging the upper three or four feet of the pile. The pump inlet and discharge openings are moulded in the concrete. Several novel schemes were adopted for depositing the concrete. A large hoisting tower, 110 feet high, alongside one end of the caisson, received the concrete from the mixers. Two mixers were used, only one being needed, the other acting as a reserve in case of a break-down, so that the process of concreting would not be interrupted. From the hoisting tower the concrete passed to a low fixed tower on the centre of the caisson which carried a distributing box from which chutes running in two directions could be supplied. These chutes lead to the top of a tremie tube hung from the boom of the derrick by means of which it was possible to control the flow of concrete at will. In building the substructure the concrete was poured in lifts corresponding to the height between the sets of bracing struts. This arrangement was to allow the timber to be removed as the concrete was poured.

Giving False Information Deprecated

The custom of giving certain information and then disclaiming any responsibility for it, has been settled also by the Supreme Court. The United States Government built a dam in Kentucky, stating in the contract: "The dam is now backed for about 50 feet with broken stone, sawdust and sediment to a height of within 2 or 3 feet of the crest, etc." Also stating: "Bidders or their authorized agents are expected to examine the maps and drawings in this office, which are open to their inspection, to visit the locality of the work, and to make their own estimates of the facilities and difficulties attending the execution of the proposed contract, including local conditions, uncertainties of the weather, and all other contingencies. The sawdust and sediment backing proved to be crib work filled with stone, and a claim was made for extra payment. The Supreme Court's decision was: "Where the specifications for repair of a dam say that the existing dam is now backed with broken stone, sawdust and sediment, and is actually backed with solid crib work, the Government must pay the increased cost of removal, not withstanding other provisions in the specifications, notifying bidders to visit the locality, estimate difficulties and obtain information necessary for an intelligent proposal. The contractor has a right to rely on a positive assertion of such a fact without an investigation to prove its falsity."

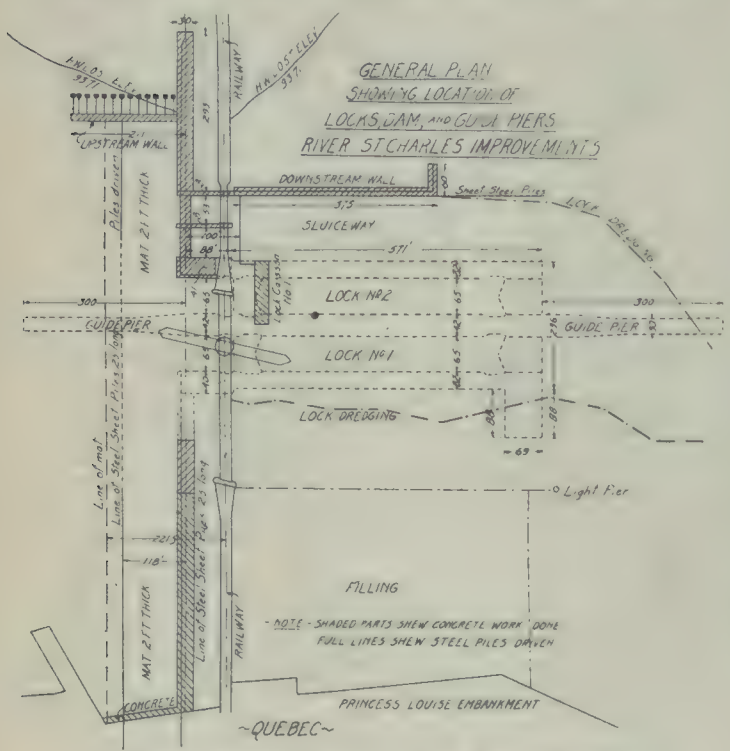
Magnetic iron corner monuments have been recommended by a United States engineer for use in survey work. He claims that by the aid of a small needle compass, they can be readily re-located without antagonizing the travelling public in breaking up several square yards of gravel road or cement walk.

Dam and Locks on River St. Charles, Quebec

EXTENSIVE works of improvement are now being carried on by the Department of Public Works, Ottawa, on the St. Charles River, at Quebec, with a view of utilizing the upper part of the river over a distance of five or six miles, which is nearly dry at low tide, for shipping purposes of a local nature and for the hauling of coal.

The works at present under contract consist in the construction of a dam and a pair of locks, 450 feet long with 65 feet clear entrance and a depth of 20 feet on the lower sill at low tide, as shown on the accompanying plans and cross sections. These works will have the effect of keeping the water in the upper reach of the river at the level of high water, spring tides, which rise 18 feet at Quebec.

The structures are to be built of concrete. The coping of the lock walls, will, however, be built of



General plan showing location of Locks, Dam and Guide Piers.

granite from the Megantic Quarries. On the north side of the locks the dam is provided with sluiceways and movable gates to properly control the water level above the dam.

The plans show a system of interlocking steel sheet piles to serve as cut-offs against percolation through the sand foundation on which the structures are built, also a mattress of concrete, 150 feet wide, above the dam.

The floors of the locks are to be 15 feet thick, heavily reinforced, to resist the hydrostatic pressure from a head of 55 feet of water, should it be necessary to empty the locks. A steel floating caisson will close the lower entrance for repairs to the lower lock gates. The works present some difficulties, owing to the fact that they are being built entirely on sand foundations and are probably the first of the kind undertaken in Canada, which makes them rather interesting.

Construction was started in 1913 and is expected to be completed in 1917. Messrs. Quinlan and Robertson, of Montreal, are the contractors. Mr. U. Valiquet, of the Public Works Department, Ottawa, is superintending engineer, and Mr. E. A. Hoare, of Quebec, the resident engineer.

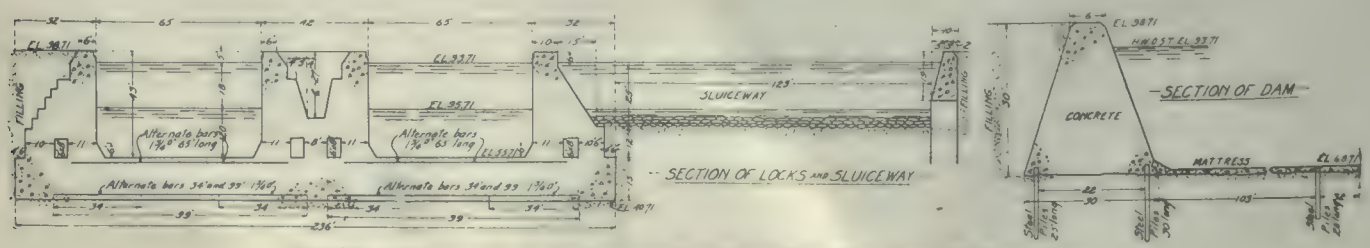
Good Roads in New Brunswick

According to a statement made by Premier Clark, the roads of New Brunswick suffered considerably during the past season on account of the exceptionally heavy rainfall and much of the work which was carried out as soon as conditions permitted was destroyed by rainfalls at a later date. The Provincial Government, however, has determined to continue the road work and to incorporate in a great part of it as many features of a permanent character as possible. A road engineer was employed some time ago and he has since been engaged in devising means by which the object of the government may be accomplished—a complete system of roads for the province. The work contemplated this year will be undertaken at once under the supervision of the engineer, and is to be carried out in a most thorough and modern manner. In the vicinity of St. John arrangements have been made for work on the following roads: the road between Musquash and Lepreaux; the road along Spruce Lake; the road to East St. John; the Upper Loch Lomond road. Tenders have also been called for the construction of a highway from the One Mile House to Brookville.

The Earth's Age as Shown by the Rocks

Scientists differ greatly as to the earth's age, estimates varying from 20,000,000 to 150,000,000 years. One of the first estimates was that of John Phillips, who in 1860 based on a study of stratified rock his assertion that the figure lay somewhere between 38,000,000 and 96,000,000 years.

The grandstand at the Canadian National Exhibition is 725 feet long, is built of brick, steel and concrete; has a seating capacity of 16,800 people, and cost $262,000.

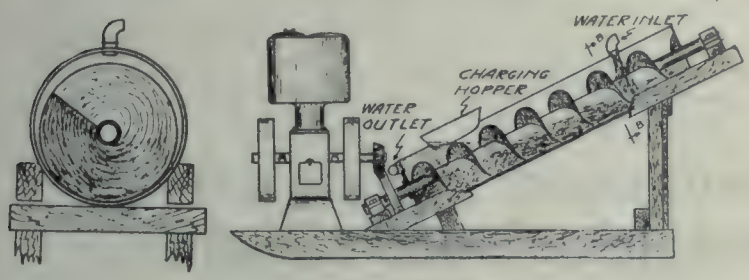


On the left, section of Locks and Sluiceway; on the right, section of Main Dam—St. Charles River.

A Portable Gravel Washer

A simple home-made apparatus for washing concrete aggregates is described and illustrated in a recent issue of "Concrete."

The device is merely a screw conveyor set into a pipe. The contractor may use his own judgment as to the size of the pipe and conveyor to be used, being careful to make the conveyor somewhat smaller in diameter than the diameter of the inside of the pipe to permit the free passage of the water, as shown in Fig. 1. The whole device should be set on a frame at an angle sufficient to permit the water to run freely to the lower end of the water outlet. The power can be supplied from the engine either by means of gears,



A Portable Gravel Washer.

as shown in the sketch, or by a belt or other convenient method. The water is admitted at the upper end, and the gravel shoveled into a hopper at the lower end, as shown at Fig. 2. By revolving the screw conveyor the gravel will be carried to the upper end of the pipe and ejected, after having been thoroughly washed. It might be necessary in some cases to fix a trap of some sort at the lower end of the pipe for the more convenient removal of sediment which may collect there, having been carried down by the water after successive washings.

This device can also be used successfully for washing sand, with a few minor alterations to suit the changed conditions.

Inclination of Conveying Chutes for Concrete

If the concrete reaches the chutes as a homogeneous mass the slope of the chutes is not of vital importance. That slope is generally the best which will allow the concrete to flow with the least velocity to insure its passage, although a vertical drop in a closed pipe is a feature of many installations on important work. Such vertical lines, however, should have baffles every few feet to arrest the drop and the concrete should be distributed at the bottom by means of a horizontal chute whenever possible and not directly from the vertical line into the forms. The required minimum slope to carry the concrete properly will vary with the character of the aggregates, the average slope for small, round gravel being 1 of rise to 3 of run, or an angle of about 18 degrees with the horizontal; the slope for 1-in. stone, about 1 to 2¾, or 20 degrees; for 1½-in. stone, 1 to 2½, or 22 degrees; and for 2-in. stone, 1 to 2¼, or 24 degrees with the horizontal. It is better practice on a long line to hang the chutes with a gradually and very slightly increasing grade as they travel toward the lower end, such a grading being less likely to cause an overflow in the chutes than the reverse. The final distributing section which places the concrete in the form should retard the concrete to as slow a movement as will carry it at all.—Engineering Contracting.

Miscellaneous

The National Conference on Concrete Road Building have now ready for distribution copies of the proceedings of their "Second National Conference on Concrete Road Building," which was held in the Auditorium Hotel, Chicago, February 15-18, 1916. These proceedings, constituting a volume of over 300 pages, are a notable treatise on concrete road construction. The price is $1.00 per volume. Remittances should be made to the National Conference on Concrete Road Building, 111 West Washington Street, Chicago.

Mr. Justice Lafontaine, in the Superior Court, Montreal, has decided that financial stringency owing to the war is not a valid defence for the cancellation of a building contract. The action was against the church authorities of Notre Dame du Perpetual Secours, the plaintiff being Mr. Henry Tessier, Jr. The church was to have cost $150,000, and on August 25, 1914, the church authorities gave the contractor orders to stop the work, this being a month after the contract was awarded. They pleaded they could not raise the money, but Mr. Justice Lafontaine gave judgment for $35,000 damages.

The new Loew theatre to be built in Montreal will be on a site with a frontage of 26 ft. 6 in. by a depth of 102 feet on St. Catharine Street West and 175 ft. x 100 feet on Mansfield Street. The plans, prepared by Mr. Thomas W. Lamb, of New York, will provide for a seating capacity of 3,000. There are to be entrances both on St. Catharine and Mansfield Streets. The cost of the land and buildings is estimated at $850,000.

The Burlington Steel Company, Limited, Hamilton, Ont., have been awarded the contract for the reinforcing steel bars required by the Canadian Government railways in the erection of their elevator at Transcona, Man.

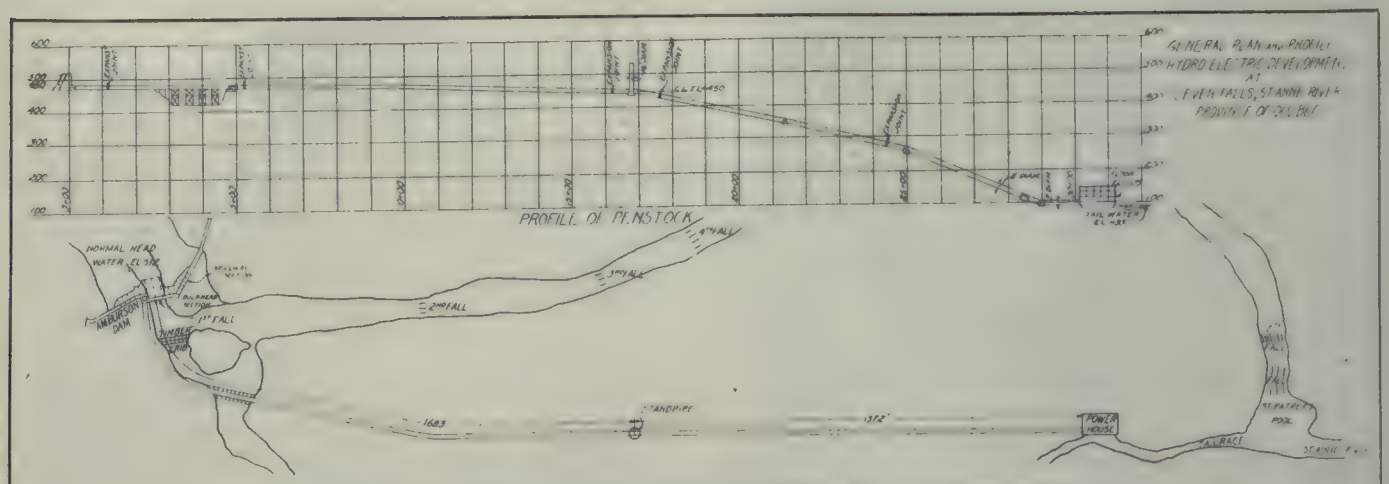
The Boving Hydraulic and Engineering Company, Limited, Lindsay, Ont., have been awarded a contract for the twin turbines to be installed in connection with the new dam for the city of Sherbrooke, Que.

The J. G. White Engineering Corporation have awarded a contract in connection with the new plant of the Ha-ha Bay Sulphite Company at Ha-ha Bay, Que., to the Raymond Concrete Pile Co., Montreal.

Messrs. Laurie & Lamb, Montreal, have received an order for a 500 h.p. Belliss & Morcom engine for the Belgo-Canadian Pulp & Paper Company, Shawinigan Falls, Que. This is in connection with an addition to their news print plant.

A prize of $100 offered by the Barber Asphalt Paving Company to students of highway engineering at Columbia University, has been awarded to Mr. Mortimer L. Neinken, of Brooklyn, for an exhaustive study on the "Comparison and Selection of Roads and Pavements."

Hypochlorite tablets to treat suspected drinking water are furnished vacationists free by the Chicago Board of Health. Moline, Ill., put up small bottles of hypo in liquid form for its citizens last year.



General plan and profile, hydro-electric development at Seven Falls for Laurentian Power Co.

Hydro-electric Power Development at Seven Falls, Ste. Anne River, Montmorency County, Quebec

The Laurentian Power Company, Limited, Quebec, controlling the Seven Falls development on the Ste. Anne River, have placed in operation a four unit hydro-electric plant and transmission system to Montmorency Falls, Que., of particular interest owing to the natural head available and the provision made for regulating the natural flow of the river.

According to the most recent regional maps of this watershed as made by the Provincial Government, the drainage area of the Ste. Anne River is 432 square miles, 400 miles of which are tributary to Seven Falls. This river has its source in the Laurentian Mountains, within the boundaries of the Laurentian National Park and flowing in a southerly direction and empties into the St. Lawrence River about 27 miles below the city of Quebec. The mountainous character of the watershed, which for the most part is well wooded and not under cultivation, thus reducing the absorption and evaporation; the northern latitude in which the head waters are situated, and the fact that a large part of the drainage basin is under preservation by the Provincial Government, are characteristics favorable to hydro-electric development and regulation of the natural flow.

The geological formation at Seven Falls is exclusively a typical Laurentian gneiss, composed of quartz, feldspar, mica and horneblendes with traces of iron pyrites. The slope or grade of the main river is high, the bed having mostly boulder stone and rock. The water is remarkably clear, free from sand or detritus at normal stage, indicating the presence of naturally filtered underground sources. Along the main river very few level reaches exist, which might be utilized for storage reservoirs, but several lakes of considerable area are available for impounding the run-off and regulating the seasonal variation in flow.

Records of precipitation taken at Quebec for the past forty years give a mean of 41.25 inches, a maximum of 52.39 inches and a minimum of 32.12 inches. Owing to the mountainous character of the Ste. Anne watershed and its higher altitude in the path of the easterly winds from the Gulf of St. Lawrence, more favorable conditions should exist for a higher precipitation, and this has been verified by records so far taken at Seven Falls.

Reconnaisance surveys of the watershed to date have established the location of storage reservoirs, whose capacities aggregate about seven billion cubic feet of storage available, which may be obtained at a reasonable cost.

Discharge records taken at Seven Falls since 1909 indicate a mean annual flow of 2.10 second feet per square mile of drainage area for this period, the maximum reaching as high as 35 second feet per square mile and the minimum 0.475 second feet per square mile.

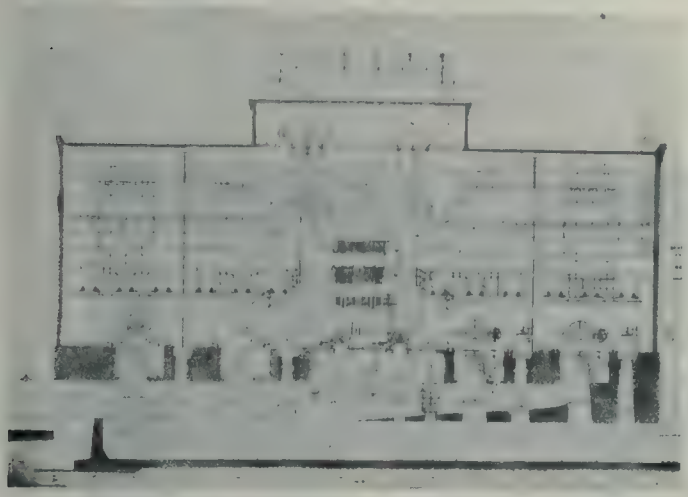
It is estimated that with the storage available, this stream may be regulated to give continousuly a discharge at Seven Falls of 450 second feet, which under the working head will produce 15,000 shaft horse power on a 100 per cent. load factor basis and 20,000 shaft horse power on a 75 per cent.

Down stream side Ambursen dam, showing penstock, bulkhead, log sluice and spillway.

load factor basis, the generating station having been designed accordingly.

Diversion and Regulating Dam

About nine miles from its outlet into the St. Lawrence, the Ste. Anne River has changed its course, forming an island between the old and the new channel, extending down stream about 3,500 feet, where the channels reunite. On the island thus formed is located the water conduit and generating station of the development. The new channel passing over a series of precipices through a gorge whose banks



Longitudinal section of generating station.

increase in height to the foot of the last falls, has formed seven distinct falls, the total difference in elevation between the water at the head of the upper falls and the foot of the lower falls being 364 feet at normal stage. This natural head has been increased at 425 feet by the erection above the upper falls of a reinforced concrete dam of the Ambursen type. The river at this point takes a sharp bend to the south before passing over the first falls, the channel being about 50 feet in width and the banks about 50 feet in height, the latter almost vertical and composed of Laurentian granite of irregular contour, offering a most suitable foundation for a dam. The main channel is spanned by the bulkhead section with buttresses spaced on 18-foot centres, raising the natural elevation of the river 61 feet and discharging it on higher rock to the south over a spillway section 150 feet in length, 85 feet of which is solid section where the height does not exceed 12 feet, the remaining 65 feet being standard Ambursen curtain section, with buttresses spaced to suit the irregular contour of the rock. The most economical layout was secured by an irregular plan, there being five angles along the centre line of the dam. The length along crest line from shore to shore is 561 feet, 395 feet of which is bulkhead section with a crest elevation 8 feet above the spillway. The buttresses of maximum section, located in the main channel, have a difference in elevation between the rock foundation and the crest of 75 feet. Four 36-inch Coffin sluice gates, located in the main channel 27 feet below the intake are provided for scouring out sand and for lowering the headrace for inspection of racks and intake. Between the bulkhead and the spillway sections a log sluice has been provided with a clear opening of 20 feet, the crest being two feet below the spillway crest and having a full apron discharge with provision for closing by stop logs.

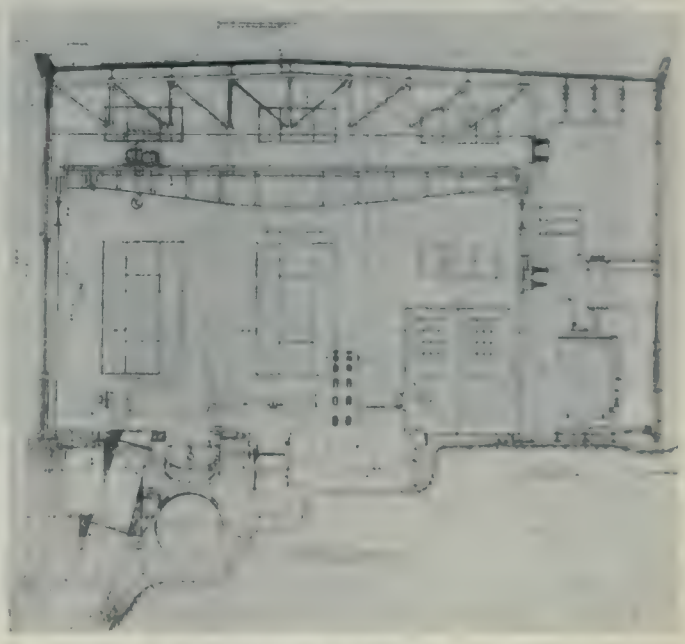
The dam impounds about thirty million cubic feet of regulating storage above the working elevation of the intake which may be increased to fifty million cubic feet by the erection of regulating sluices on the main spillway controlled by stop logs or gates.

The intake to the water conduit is located between two buttresses spaced on 18-foot centres, heavily reinforced and protected in front from floating debris and ice by a reinforced concrete apron, back of which are located the rack bars, 3 in. x 5/16 in. x 28 ft. 6 in. in length, spaced on 1¾-in centers. The floor of the intake chamber is 36 ft. 6 ins. below the crest of the spillway. The rack bars are set at an angle of 60 degrees and are completely submerged. They are supported on heavy I-beams set between the buttresses and rest on a deck slab extending above the water line, back of which is the raking platform with an ice chute for sluicing purposes during cleaning of the rack bars.

The head gates consist of two 4 ft. x 8 ft. Coffin standard cast iron sluice gates, bronze mounted throughout, having spigot ends and rising stems operated by ball bearing, variable power stands with provision for hand operation or motor control from the generating station switchboard. The intake is formed in the concrete and heavily reinforced, reducing from a rectangular section to a conical section terminating in a steel plate thimble riveted to the main penstock.

Water Conduit

Between the intake and the generating station, a distance of 3,098 feet measured along the conduit, the water is conducted by 1,677 feet of flow pipe terminating in a standpipe 16 feet in diameter and 79 feet in height and 1,421 feet of pressure penstock. Both the flow pipe and the pressure penstock have a minimum inside diameter of 8 feet, the courses being telescopic. When it reaches a point 100 feet from the station the pressure penstock is reduced in diameter to 7 feet, and on reaching the station it is continued by a steel plate distributor set in the concrete foundations of the station and supplying the spiral casings of the four main turbine units by steel plate nozzles. All plate used in the conduit is open hearth boiler flange quality. Those used in the flow pipe are 114 inches in width, ⅜ in. in thick-



Transverse section of generating station.

ness, two plates per course, double riveted longitudinal and girth seams, caulked on the outside only.

From the intake the grade for the first 1,030 feet is 0.66 per cent., the remainder is set to a grade of 4.93 per cent. On leaving the intake the flow pipe turns an angle of 65 degrees on a radius of 200 feet and then crosses a gorge on structural steel trestle bents spaced 18 ft. 3½ in. centres.

varying in height from 15 to 40 feet, the distance between abutments being 200 feet. The pipe is supported at the centre of every alternate course by structural steel saddles set on concrete piers with an intervening steel plate to allow of movement of the saddle. Three expansion joints of the bellows type are used between the intake and standpipe.

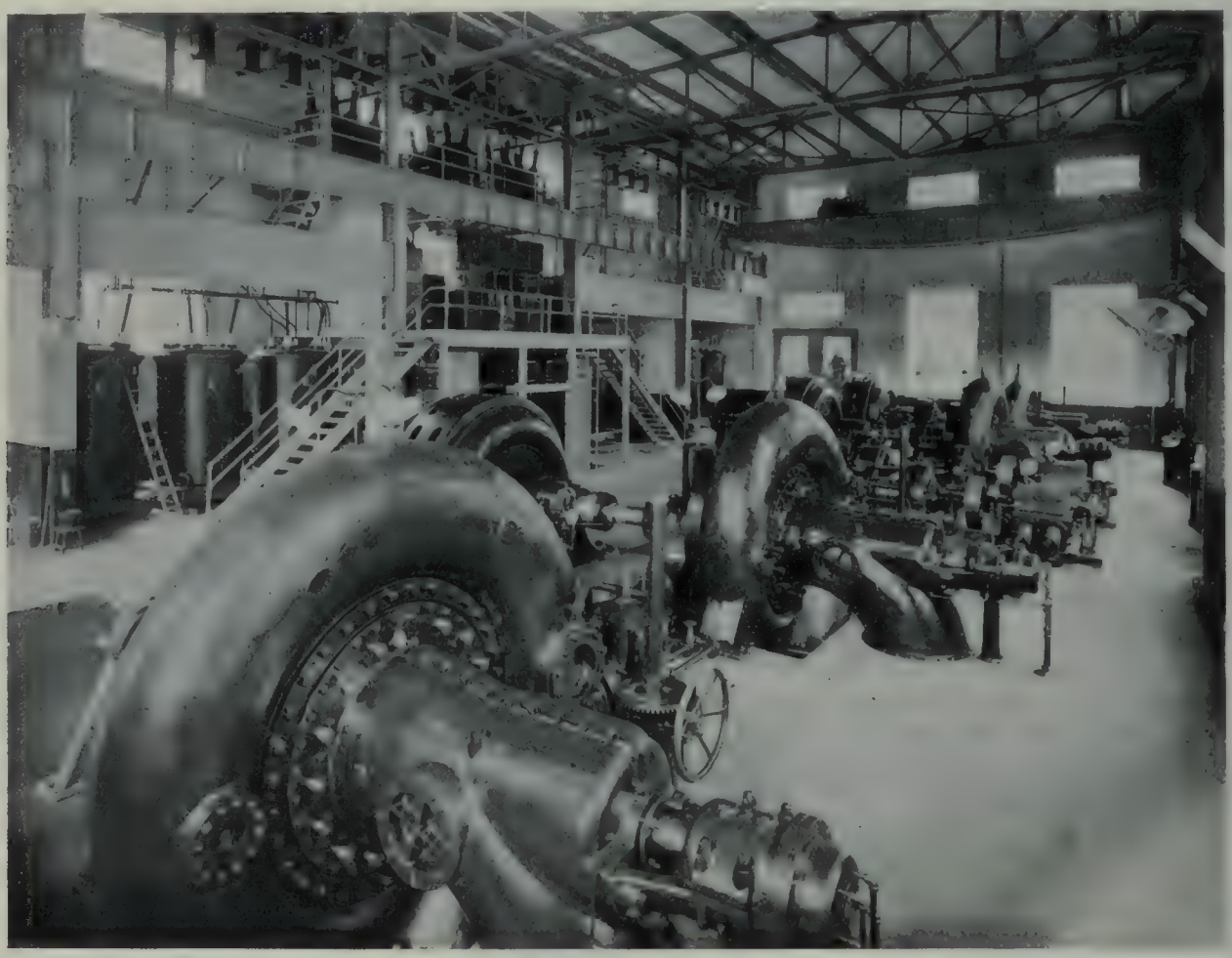
The pressure penstock varies in thickness from ⅜ in. to 13/16 in. Plate ½ in. in thickness and above is edge planed, rivet holes sub-punched and reamed, with triple riveted butt strap longitudinal seams and double riveted girth seams. The grade for the first 450 feet from the standpipe is 20.4 per cent., where it increases to 25 per cent. for a distance of 353 feet and continues at a grade of 41.7 per cent. for 436 feet, terminating in the reducing section from 8 ft. to 7 ft., and is continued horizontally through a curve of 74 ft. radius to the station. The foundation for this penstock being mostly sand and cemented gravel, particular care has been taken to carry down the concrete supporting piers to good foundation and to provide cut-off drains for carrying off the surface water. At all changes in grade heavy anchor piers have been placed, embedded in which are heavy anchor angles riveted to the penstock.

All plate before leaving the shops of the contractors was coated with linseed oil and after erection given three coats outside and two coats inside of special Detroit graphite penstock paint.

The completed conduit and standpipe are enclosed in a wooden housing covered with tar paper and sheet metal for protection from frost.

The station has a normal full load rating of 18,720 kv.a. generated by four units of 4,680 kv.a. each, with an overload rating of 25 per cent. for two hours. Three complete units are at present installed; the turbine for the fourth unit is in place, the generator and its bank of transformers to be installed later.

Each unit consists of a horizontal, 6,000 b.h.p. Allis-Chalmers (Milwaukee), single discharge, single Francis runner, set in a cast steel spiral casing, operating under a normal effective head of 410 feet at a speed of 630 r.p.m., connected by solid flanged coupling to a 4,680 kv.a., 6600 volt, 63 cycle, 3 phase, revolving field Canadian General Electric generator which is provided with a solid cast steel rotor, water cooled bearings and provision for ventilation by solid cast steel rings with fan blades in one piece securely bolted to the cast steel spider of the rotor. The total weight of the complete generator is 140,000 lbs., the weight of the revolving field and shaft being 60,000 lbs., giving a flywheel effect of 200,000 feet pounds without recourse to any auxiliary flywheel.



Interior generating station, Seven Falls, Quebec—Laurentian Power Company.

These machines have been given a runaway speed test of 1200 r.p.m. for one hour at the factory before shipment, and are guaranteed to withstand short circuit current for one minute at any load.

The generator voltage is raised to 50,000 volts by banks of three single phase, 1566 kv.a., oil insulated, water-cooled Canadian Westinghouse transformers delta connected on high and low tension sides.

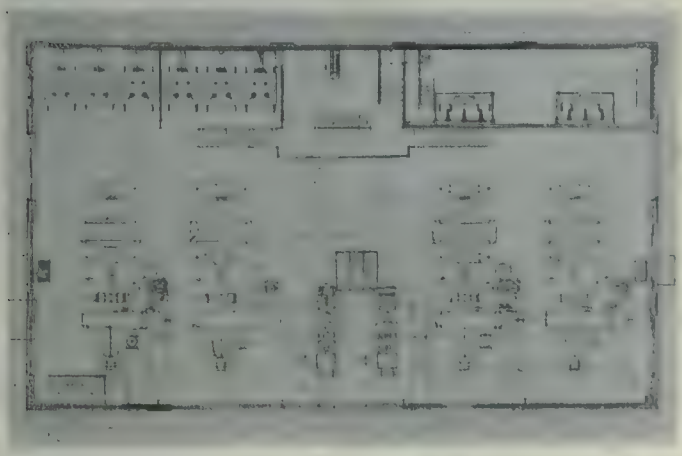
Duplicate exciter sets, each of sufficient capacity for the excitation of the four main units, are installed, consisting of Canadian General Electric, 130 kw., 125 volt, 900 r.p.m. interpole generators, water wheel driven by Canadian Allis-Chalmers impulse wheels with provision for motor drive

by 200 h.p. C. G. E. induction motors supplied from the 550 volt local service circuits. The exciters are arranged for operation with Tirrill regulators. No governors are used in connection with the impulse wheels, but provision is made for motor control of the needle nozzles from the switchboard, if required.

The above equipment, in conjunction with the duplicate, 24 mile, 50,000 volt transmission lines, is controlled by benchboard and auxiliary switchboard centrally located on a gallery above the main floor from which the operator has a clear view of all units. All high and low tension switches and control equipment was installed by the Canadian General Electric Company.

The Allis-Chalmers, Francis turbine runners are cast solid, of special runner bronze, having a mean diameter of 40 inches, the width of the inlet between the guide vanes being 5¾ ins., particular care being taken to insure uniform thickness and spacing of the vanes, the inlet and discharge edges being finished to template and all water passages given a smooth finish. The runners are ream-bolted to a steel flange forged solid with the open hearth steel shaft, carefully balanced and are designed to withstand the runaway speed due to full gate and no load on the generator. The axial thrust of the runner due to the single discharge is balanced hydraulically by opposing annular spaces provided on opposite sides of the runner and so arranged that any movement of the rotor axially causes the throttling of the flow through clearance spaces at one end and corresponding relief of the pressure at the opposite end, so that the rotor is returned automatically to its original position, a small thrust bearing being provided at the end of the shaft to limit the axial play during stopping and starting.

The spiral casings in which the runners are set, are cast in one piece of special cast steel, in the form of a true evolutionary spiral, with decreasing area in proportion to the discharge through the guide case. The sides of the casing are not bolted together as is the usual practice, but at the inner circumference tension members are provided cast integral with the speed ring, curved in section so as to conform to the flow lines and produce a minimum disturbance, absorbing the strains imposed by the internal water pressure.



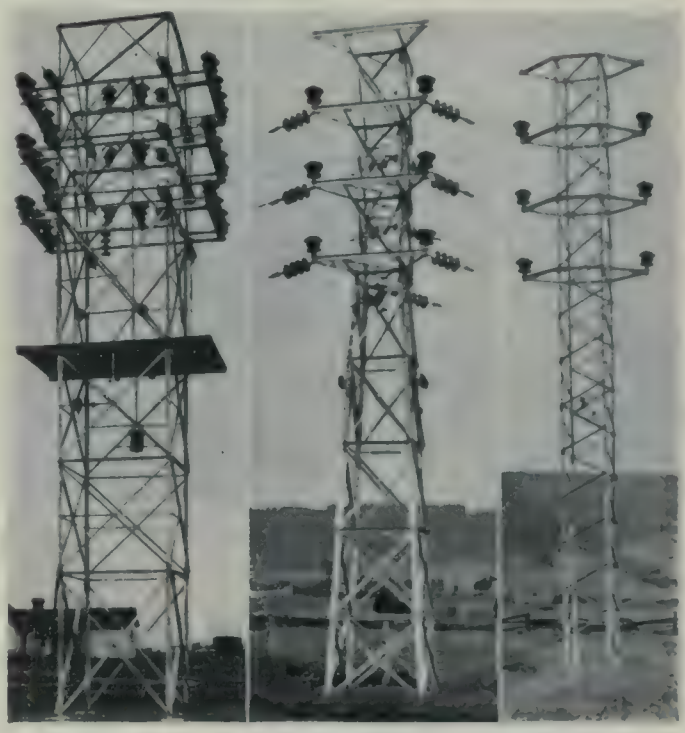
Floor plan of generating station.

These casings have successfully withstood a hydrostatic pressure of 400 pounds per square inch, before leaving the shops of the manufacturers.

The bottom inlets to the turbines are controlled from the main floor by hand operated, 48-in. butterfly or wicket valves, designed to allow of closing under penstock pressure, having cast steel bodies and wickets with the shafts mounted in bronze bushed bearings.

Each turbine is provided with the latest type of Allis-Chalmers, oil operated governor especially adapted to heavy duty service under fluctuating loads and severe penstock conditions. The pressure is maintained by a belt-driven rotary pump, mounted in the cast iron housing of the governor, taking its suction from a separate receiving tank located under the floor near the governor and delivering the oil under air pressure to a separate steel plate pressure tank; the entire oil system being "open," so that neither vacuum or pressure can be formed in the receiving, tank circulating oil being in continuous contact with the air.

Control of penstock pressure, which is normally 172 lbs.



Switching tower. Right angle tower. Standard tower.

per square inch in the distributor, is maintained by Allis-Chalmers, governor operated, automatic, pressure regulators or relief valves. Each turbine has a by-pass outlet located close to the inlet of the casing which is connected to the main body of a 15-in. relief valve with separate discharge piping to the tailbay, capable of discharging 75 per cent. of the water required for full load operation of the turbine, and is guaranteed to control the rise in penstock pressure within 15 per cent. with full load thrown off the generator. These regulators may be operated through positive and substantial connections synchronously with the gates or the rate of discharge may be adjusted to suit the pipe line and operating conditions.

Auxiliary to the four relief valves connected to each of the turbine casings, a fifth regulator is connected to the penstock distributor of the same size and general construction, except that it is operated directly by pressure from the penstock and may be adjusted to discharge at a pre-determined pressure. It is estimated that in the event of all four units being in operation and the full load be dropped from all simultaneously, the pressure rise in the penstock will not exceed 30 per cent. with all pressures regulators adjusted and in operation.

The station building, 114 ft. x 66 ft. in plan, consists of rubble concrete substructure supporting structural steel columns which divide the station into five bays and support the roof trusses and runway for a thirty-ton crane, the walls acting simply as curtain walls reinforced for temperature strains only. The substructure, founded on rock over 90 per cent. of the area, the remainder being on hard pan,

cemented gravel and small boulder stone, has imbedded in it the seven-foot diameter steel plate distributor supplying the main turbines through steel plate nozzles set at an angle of sixty degrees with the distributor and connected in the 48-in. butterfly valves controlling the bottom inlets to the main turbine casings set vertically above the distributor. Particular care has been taken in the design of these intake nozzles to reduce the loss in head from change in direction

Penstock crossing gorge on steel trestle.

of flow, sharp bends or obstructions to the path of the water to the scroll casings.

The upper sections of draft tubes and discharge piping from relief valves are made of steel plate, the lower sections being moulded in the concrete foundations, flaring as they approach their exits to the tailbay adjacent to the station, which is lined with a concrete measuring weir located near the down stream end of the building.

Inspection and ventilating tunnels are provided in the station foundations for examination of piping below the floor line and ventilation of main generators with air drawn from the exterior of the building.

Of the five bays dividing the station, four contain the main units with their corresponding bank of raising transformers, above which a gallery extends for the operating of the 50,000 volt disconnecting transformer switches, the roof of which supports the 50,000 bus-bars extending the full length of the station, supported on suspension insulators. The centre bay contains the exciter sets, floor space for dismantling a unit, back of which is located the 6600 volt bus bar structure and circuit breakers, the local service transformers and the main generator field rheostats. Above the main floor in this bay is the operating gallery containing the benchboard, exciter and local service switchboard, and the 6600 volt bus-bar tie switch, and on another gallery above the operating gallery is located the 50,000 volt line and bus tie circuit breakers, and on the roof directly above is housed the electrolitic lightning arresters directly in line with the transmission lines.

The station may be operated with two units on one transmission line as two separate stations, complete flexibility and interchange being provided in the switching equipment. During the past few months the plant has been operating in parallel with the existing plants of the Quebec Railway, Light, Heat & Power Company with entire satisfaction.

Transmission System

The two 50,000 volt lines from Seven Falls to Montmorency Falls, a distance of 24 miles, each have a capacity of 10,000 kw. The first five miles from the generating station is over a private right-of-way, 66 feet in width, the remaining 19 miles being along the right-of-way of the Quebec Railway, Light, Heat & Power Company, over which the Laurentian Company have been granted rights.

The three wires of each circuit are composed of No. 1/0, seven strand, hard drawn copper cable, the centre strand being soft drawn. The cables are arranged in a vertical plane on each side of the tower, supported on 66,000 volt pin type insulators. Above each circuit is a ⅜-in. galvanized stranded ground wire, supported on channel cross arms, similar to those used for the line conductors. The vertical spacing between all wires is 4 ft. 6 ins., and the horizontal spacing between circuits is 8 ft.

The type of standard tower or latticed steel pole used was designed and fabricated by the Canadian Bridge Company and consists of a straight shaft, 40 feet in height from the upper cross arm to the concrete footing, composed of four angles 3 in. x 3 in. x 3/16 in., 16 ft. long, set symmetrically on the corners of a square whose sides are 3 feet, spliced to 2¼ in. x 2¼ in. x ⅛ in. angles 26 feet in length. These angle legs are not tapered but the same distance apart for their full length and are latticed symmetrically on all sides by 1¼ in. x 1¼ in. x ⅛ in. angles secured by half inch bolts formed of 3 in. channels, carrying the two ground wires and the six main conductors. The footing in earth consists of 3 in. x 3 in. x 3/16 in. angles, 6 ft. 7 ins. long, securely braced together and bolted to the tower legs.

All material used throughout is open hearth steel, hot galvanized, except the footing, embedded in concrete. Standard towers are increased in length where required by the addition of extension sections of the required length, members being strengthened where required and footings spread at the base. The spacing on tangents for standard towers is 250 feet. Strain towers with footings spread 7 ft. 8 ins. along the line, are used every two miles. Each circuit is transposed three times in the total distance of 24 miles, the

Generating station, discharge side.

transposition being made on standard 40-foot towers, with special cross arms and extra heavy shafts. Two river crossings are encountered, requiring extra heavy 66-foot towers with spread footings, supporting copper clad steel cable in the place of line cable. The lines are sectionalized into three sections by special 50-foot switch towers, equipped with disconnecting switches manually operated from a platform 10 feet below the lowest conductors. At the junction of the private right-of-way with the Q. R. L. & P. Co. right-of-way a right angle in the line is turned on a special heavy 40-foot

tower with spread footings, no anchor guys or lateral bracing being used.

All structural steel footings in earth are encased in concrete, the footing being set in place on completion of excavation and removable forms used to provide a six-inch wall of concrete surrounding the four legs, leaving an annular square space 2 ft. 6 ins. in the centre, which is back filled and tamped to within 6 inches of the top, the whole being capped with about six inches of concrete sloping to the outside edges. All connections between tower legs and footings and where the steel emerges from the concrete are given a coat of thick paint for protection from corrosion.

Personnel

The Ambursen Hydraulic Construction Company of Canada were contractors for the main dam and headworks, having Mr. A. G. Gardner as Superintendent of Construction. The Walsh Plate & Structural Works were contractors for the penstock, fabricating the material at their Drummondville, Que., shops. Mr. E. A. Wallberg, C. E., Toronto, was contractor for the generating station and transmission line, having Mr. J. R. Nichols as Superintendent of Construction. Mr. James Ruddick is Engineer and Manager for the Laurentian Power Company, with Mr. E. R. Shirley in charge of the operation of the station as Superintendent.

We are indebted to Mr. A. R. Henry, M. E., consulting engineer, Montreal, for the above description of this development, under whose supervision the surveys, plans and specifications were carried out. During construction Mr. Henry has been represented by Mr. C. H. Hollingsworth, C. E., and Mr. J. R. Montague, B.Sc., as resident engineers at the site.

Conservation of Fish, Birds and Game

A report just issued by the Commission of Conservation, "Conservation of Fish, Birds and Game," directs attention to the great value of these resources to Canada. The volume is a report of the proceedings of a conference of the Committee on Fisheries, Game and Fur-Bearing Animals of the Commission, and contains a fund of information regarding the present condition and the necessity for protection of Canada's fish, birds and animals. Canada is taking a prominent part in the international movement for the protection of wild life. A Migratory Bird Treaty between Canada and the United States is under consideration. Through the influence of the Commission of Conservation and other interests, bird reservations are being created, where the birds may find safe nesting and breeding places. The fur-bearing animals of Northern and Western Canada are being rapidly exterminated. This is clearly shown by the present report. To secure their more adequate protection, the Commission is advocating the amendment of the Northwest Game Act to place responsibility for its administration upon the Dominion Parks Branch, which already protects the animals in the Dominion National Parks. The future of the fisheries of Canada is dealt with in an able manner. That they are of great present value is recognized, but there is also a potential value in our oceanic and inland waters which, upon development, would mean the creation of new industries. To meet this condition, the Commission is suggesting vocational training and simple demonstration stations for the fishermen, that they may take advantage of the most practical and modern methods of their calling. The report is replete with illustrations applicable to the subject matter.

Ottawa's civic waterworks committee has been abolished and its powers and duties pass into the hands of the board of control. A proclamation to this effect was issued by the Lieutenant-Governor recently in Toronto.

Personal

Mr. Leonard Foulds, senior partner of the firm of Foulds & Bowes, architects and engineers, 166 Bay Street, Toronto, and son of Sir Samuel Foulds, an English surgeon recently enlisted with the 220th York Rangers as a sergeant.

Mr. C. H. Speer, who for a long time has been associated with the Algoma Steel Corporation, has been appointed Chief Engineer in succession to Mr. J. D. Jones, who has been engaged to fill a similar position in the large Gary steel plant of the United States Steel Corporation.

Mr. T. A. Jardine Forrester, who has been for several years waterworks engineer for the city of Quebec, a position which he resigned some short time ago, left for Scotland recently. It was under Mr. Forrester's supervision that the forty-inch main was constructed, which has greatly increased the pressure of the city's water supply, and it was to his efforts that the success of the re-organization of the fire department was also largely due.

The appointment of Lieut. Peter D. D. Lyall, of the 90th regiment, Winnipeg Rifles, to the 190th overseas battalion, has recently been reported. Lieut. Lyall, since the death of his father, Peter Lyall, the widely known general contractor, has had charge of the big contracting firm, which has carried out and has on hand some of the finest and most extensive building operations in the Dominion. Eminent examples of the firm's work are the Parliament Buildings, Ottawa, and the Toronto Union Station, now under construction, and the Union Station and Royal Alexandra Hotel, Winnipeg. Lieut. Lyall was born in Montreal in 1877, and was educated at Fettes College.

Obituary

Alexander McCartney, Kingston's oldest building contractor, died recently at the age of 66.

Alexander Murphy, who for twenty years was clerk of Fitzroy township council, recently passed away after a long illness. In his younger days the deceased was a building contractor.

Mr. George Rennie, a well-known building contractor, of North Toronto, Ont., died recently at his home at 41 Helendale Avenue. Mr. Rennie was in his 61st year, and was born in County Tyrone, Ireland, coming to Canada over 30 years ago. For the past 15 years he has resided in North Toronto, taking a prominent part in its public life.

The death of Wm. McGrath, aged 51, occurred recently at his home in Newcastle, N. B., following an acute attack of diabetes. Mr. McGrath was a stonemason by trade and it is said there is hardly a stone building in the town of Newcastle in the building of which he has not participated. He was born in Pokemouche, Gloucester Co., but had lived in Newcastle for the last thirty years.

Mr. W. B. Stephens, one of Owen Sound's best known citizens, passed away recently at the age of 70 years. Mr. Stephens was engaged in the hardware business for a considerable number of years. He sold out the business, however, in order to accept the position of secretary-treasurer of the Owen Sound Stone Co., and on the termination of this company, entered the insurance business.

Charles A. Stoess, one of the best known engineers in British Columbia, died recently at his home on Nelson Street, Vancouver. He was one of the pioneer civil engineers and land surveyors of the province, having helped in the construction of the Canadian Pacific Railway over the Rockies in the early days. He was also prominent in connection with the Kelowna irrigation scheme, which was carried out by him about four years ago. He was born at Liverpool, England, in 1853, and came to Canada about 27 years ago. He went west, working as a civil engineer for the C. P. R.,

and for the past twelve years has lived in Vancouver. He was a member of the C.S.C.E., and an associate member of the I.C.E.

The death occurred recently in Toronto of Ernest G. Barrow, for many years city engineer of Hamilton. Mr. Barrow was engaged for some time as assistant consulting engineer and afterwards succeeded E. B. Wingate as city engineer, retiring in 1909. During his period of office the waterworks system was remodelled, and the third main and James Street reservoir constructed. Before entering the civic employ Mr. Barrow was a member of the firm of Barrow & Hunting, contractors, who constructed the Mimico waterworks.

Mainly Constructional

East and West—From Coast to Coast

Building permits up to the end of June in Calgary, Alta., amounted to $148,000. The total for the whole of last year was $150,500.

The Victoria Gravel Pit Company, Limited, has been incorporated with a capital of $100,000, head office at Victoria, B. C.

Contractors tendering for work in connection with the mechanical gravity filter at Drummondville, Que., are required to suuply their own plans and specifications.

It is stated that the asbestos industry in Quebec is faced with a serious rival in the United States, owing to the quality and abundance of the deposits of chrysotile asbestos which have recently been uncovered in Arizona.

According to a statement made by Hon. Mr. Lucas, the preparation of the plans and laying out of the engineering work in connection with the Chippewa Creek power development scheme, are proceeding with all despatch. No delay has been made, he states, and it is hoped that the plans will be ready to file and advertise at an early date.

An agreement has been made between the York Township Council and the city of Toronto whereby the city is to supply water to the congested districts of the township. As soon as the plans are completed the work will start. Water pipes will be laid down on the local improvement plan, practically along the lines adopted by the city.

The lumber and implement sheds being built at Napinka, Man., for Mr. J. P. Carnduff, are nearly completed. The size of the lumber shed is 18 ft. x 80 ft. and it will be modern in every respect. The implement warehouse is a structure 18 ft. x 36 ft., with a front open shed 18 ft. x 18 ft., and will be used as a display shed. The contractors are H. S. and M. S. DeWitt.

It is reported that the increased automobile traffic occasioned by the interchange of licenses between Ontario and different states of the Union has caused considerable damage to the roads of Essex County, Ont., and the county council are introducing a by-law providing for the paving with concrete or building with crushed stone of more than one hundred miles of road.

The building trades in Hamilton, Ont., are reported to be very active. A number of the large firms are building or have finished additions to their plants. These include the Canadian Cartridge Company and the Steel Company of Canada. The major portion of the work that is being done, however, is on workingmen's houses, the value of which ranges between $1,500 and $2,500.

The Elora White Lime Company, of Elora, Ont., which owned and operated the property and kilns at the east end of the village, has sold out to the Alabastine Company, Limited, of Paris, Ont. The White Lime Company had four kilns in operation, manufacturing a special line of hydrated lime for which the rock at Elora seems exactly suited. Mr. J. F. Cameron is manager for the Alabastine Company.

Statistics show that the gross revenue derived from motor vehicles and licenses in the United States during 1915 amounted to $18,245,713.09. Of this amount, $11,555,459.25 was available for road work under the direction of state highway departments or similar authorities, and $4,657,929.39, under the direction of local authorities. The average gross revenue return per motor car registered was $7.46.

An interesting book has recently been issued by the Nova Scotia Steel & Coal Company, Limited, under the title, "A Brief History of a Great Industry." It is a beautifully illustrated book of more than one hundred pages. Each page contains a half tone of some of the "Scotia" buildings, plant, equipment or products, accompanied by detailed descriptive matter. An outline is also given of the origin and development of the company.

Precious' farm, near Wabasso park, was the scene of the recent annual picnic of the Hamilton Builders' Exchange. Motor cars and motor boats were utilized to get to the destination, and about sixty members gathered to enjoy the outing. A baseball game was a feature of the day's sport, followed by field games of various natures, and lastly the supper. The affair was in every way a success and was greatly enjoyed by all present.

Building permits for the first five months of the year in Brandon, Man., total in the neighborhood of $175,000, while for the same period last year the total was only something like $5,000. The most important buildings to be erected are probably a theatre and four stores on Tenth St.

At the annual meeting of the Building Trades League, held recently at the Labor Temple, Toronto, officers were elected as follows: Mr. John Sutherland, president (re-elected); Mr. W. McGarry, vice-president; Mr. R. Banks, secretary; Mr. S. Garland, treasurer; trustees, Messrs. W. A. Joyce, T. Stuart and J. McCormick. The executive committee appointed consisted of Messrs. Cheeseman, Garland, C. Riley, Stuart, Ashton, D. Banks, and the officers.

Paul Mercier, chief city engineer of Montreal, recently asked the board of control to appoint a consulting engineer to oversee all the activities of the public works department, and report thereon to the controllers. In his report Mr. Mercier claims that too many engineers in the employ of the city are under the influence of controllers, and advises the appointment of someone who would be above reproach and immune from the attacks of interested parties.

The members of the Road Commission appointed by the provincial government to take over the North Shore Turnpike roads in the province of Quebec, held a recent session deciding upon tenders and the issuing of orders for the preliminary work in connection with the permanent roads in proximity to Quebec city. Already the work has been started on the reparation of the road between the city limits, on St. Foye road and St. Augustine, to connect with the Quebec-Montreal highway.

Mr. F. C. Laberge, of Montreal, has made plans for the supply of water to the town of St. Leonard de Port Maurice, just north of Montreal. It is proposed to take the supply from the city of Montreal and to lay an 8-in. cast iron main

along the principal road of the town, with ¾-in. and ⅝-in. connections to the various houses along this road. The pipes will be of a total length of 11,500 feet if the water is taken via St. Michel, and 15,300 feet if taken from the limits of the city of Montreal. The estimated cost is $50,000.

Mr. R. S. Kelsch, consulting engineer, Power Building, Montreal, is preparing specifications for one additional twin runner turbine of 5,000 h.p. capacity, together with penstock and all auxiliaries, including a new generator and accessories. The apparatus is to be installed in the Shipshaw plant of Price Brothers & Company, Limited, Shipsaw, Que.

The real estate and personal property of the Nova Scotia property of the Nova Scotia Car Works was recently sold at auction by the liquidator. The property was knocked down to F. B. McCurdy, M. P., for the Canada Corporation, for $167,500, which price is subject to a mortgage at $115,000, held by the city of Halifax. The sale was under the Winding-up Act, but it is understood that the old security-holders of the company now in liquidation will be afforded the opportunity of protecting their investment by joining in the re-organization contemplated by the purchasers, and the property will be offered to them at the cost price.

The Victoria Park Commission have laid twenty miles of roadway between Niagara Falls and the ferry dock in Fort Erie. This forms one section of the boulevard which, when completed, will connect Lake Ontario and Lake Erie. Water-bound macadam has been used for the most part on this portion of the road. The few miles leading into Fort Erie, however, are of concrete. The work on the roadway between Niagara Falls and Niagara-on-the-Lake has not yet been started, but it is expected that it will be undertaken shortly, and when this portion has been completed the boulevard will stretch for 36 miles between the two lakes.

Messrs. Beatty Bros. are having plans prepared for an extension to their plant at Fergus, Ont. The new building will be about 400 feet long and 72 feet wide, of saw-tooth construction. It is to be erected alongside their new premises near the stations, paralleling them at 66 feet apart. The intention of the firm is to take all the iron-working machinery to the station plants, leaving the building on the Grand River for their woodworking machinery. It will also house the sheet iron department and provide a large addition for shipping facilities. The sheet iron department will then make their tanks, which are at present purchased from other firms.

Mr. R. S. Kelsch, consulting engineer, has just closed a contract with the Canadian General Electric Company for a steam turbine for the Acadia Coal Company, of Stellarton, N. S. The turbine is five stage, 3,000 r.p.m. Capacity of generator will be 5,000 kv.a., speed 3,150. The generator will deliver 3 phase, 50 cycle current. The Canadian General Electric Company will also furnish the Worthington condenser, pumps, and all auxiliaries. The odd voltage and frequency selected is due to the fact that this turbine will operate multiple with the coal company's existing turbines furnished some years ago by Allegemeine Elektricitats Gesellschaft, Berlin, Germany.

Contracts have been awarded as follows in connection with highway work in the province of Manitoba:—Campbell Bros., of Manitoba, the grading of 37 miles of road for Ellice municipality; Hagel & Dunlea, of Winnipeg, the construction of a concrete bridge and culvert in Ritchot municipality at a cost of $3,372; H. Sigurdson, of Winnipeg, the construction of a concrete bridge and culvert at Dominion City in the municipality of Franklin at a cost of $3,688; Brown Construction Co., of Winnipeg, concrete culvert in Lansdowne municipality at a price of $638. The Good Roads Board has approved the plans for a Howe truss bridge over the Pembina River, near Rock Lake, at a cost of $1,600. This is an inter-municipal bridge, Argyle and Louise being interested.

It is understood that the re-organization of the work-department of the city of Ottawa by Mr. A. F. Macallum, chief engineer and commissioner of works, will include dispensing with the services of Mr. R. L. Haycock, acting waterworks engineer, and the appointment of Mr. F. C. Askwith, formerly acting city engineer, as deputy city engineer. Mr. Askwith has been in the city's service for many years and was formerly assistant city engineer in charge of road work. The dismissal of Mr. Haycock is not a reflection on his ability, but in the opinion of Mr. Macallum the department is top-heavy and in letting Mr. Haycock go no other man will be taken on to replace him.

"Don't worry when you stumble—remember, a worm is about the only thing that can't fall down."

Owing to the tardiness of the manufacturers in the delivery of steel, the work of the Frank Farrington Company, of Detroit, on the new Princess Theatre, Toronto, has been somewhat delayed, and it is possible that the opening will not take place till October 15, some three or four weeks later than had been anticipated. Deliveries are improving, however, and operations are now progressing fairly rapidly. The entrance way to the theatre has been widened from 15 to 28 feet. This hallway will be 74 feet long from the street to the foyer. The auditorium will be nearly 100 feet square, and the stage, not included in these figures, will be 40 x 41 feet. A portion of the stage floor (35 x 26 ft.) will be movable to permit of submerged tanks in water scenes or to meet the extraordinary requirements of other large spectacles. The stage floor is beamed and partly finished, portions of the walls are erected, and the greater part of the girders and other steel beams are already in place. No pillars will obstruct the view of the stage, either from the single balcony or the ground floor. The seating capacity will be about 2,000 persons. The cost of the building is in the neighborhood of $150,000.

Trade Publications

Indicators—The Trill Indicator Co., of Corry, Pa., have issued a new and complete book on engine indicators and indicating. It is well illustrated and describes in detail the construction and purpose of the several parts of both the outside and enclosed spring types of indicators. Detailed instructions are given on the application and use of the indicator and the planimeter, also discussions regarding the various types of engine.

Soot Cleaners—Catalogue issued by the Vulcan Soot Cleaner Co., Du Bois, Pa., describing and illustrating Vulcan Soot Cleaners as applied to boilers, super-heaters, economizers, garbage destructor boilers, waste heat boilers, and similar apparatus.

Mr. Charles Hodgson Osler, engineer and superintendent of the gas department of the Montreal Light, Heat and Power Company, died suddenly from heart failure on July 8, in his office, while attending to business. At one time he was employed on the Kingston & Pembroke Railway, and later was C.P.R. engineer in charge of locations on the western lines. Mr. Osler, who was 56 years old, joined the Canadian Society of Civil Engineers as associate member in 1887, and in 1892 was made a full member.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Assiniboia, Sask.
The time for receiving tenders on the construction of a waterworks system, etc., has been extended until August 15.

Drummondville, Que.
The report published in our issue of July 26, under this head, incorrectly stated that Messrs. Ouimet & Lesage, of Montreal, were the consulting engineers for the proposed mechanical gravity filters. Each contractor tendering is required to furnish his own plans and specifications.

New Toronto, Ont.
Tenders on the construction of sewers and a pumping station for the Town Council will be received until August 14. Plans and specifications at office of the engineer, T. Loews, Mimico.

North Bay, Ont.
The Town Engineer, H. J. McAuslan, will receive tenders until noon, August 5, for the supply and delivery of about 600 feet of 30-inch reinforced concrete pipe and 2,700 feet of 10-inch vitrified salt-glazed pipe.

Osgoode Township, Ont.
The Township Clerk, Frank Iveson, Metcalfe, will receive tenders until 3 p.m. August 5, for the construction of a drain, estimated to cost $6,700. Engineers, Magwood & Stidwell, Cornwall.

Sault Ste. Marie, Ont.
Tenders will be received until 5 p.m., August 9, for the construction of pavements for the City Council. Estimated cost, $34,000. Engineer, W. W. Van Every.

Sherbrooke, Que.
The City Council are having plans prepared for the construction of concrete and brick trunk sewers in the South Ward at a,n approximate cost of $45,000. Engineer, Thomas Tremblay.

St. Boniface, Man.
The City Clerk, J. B. Cote, will receive tenders until 5 p.m., August 11, for the supply of four gates to prevent regurgitation in sewers. Tenders must be accompanied by plans and specifications. Engineer, M. P. Blair.

St. Lambert, Que.
Tenders are now being received for the construction of about 3,000 feet of sewer for the Town Council. Engineer, H. A. Gibeau.

Victoria, B.C.
The City Council intend to make repairs to Oak Bay Avenue, at an approximate cost of $12,000. Macadam or asphalt construction. Engineer, C. H. Rust.

CONTRACTS AWARDED.

Niagara Falls, Ont.
The contract for construction of about 20,000 square feet of concrete sidewalks and 3,800 lineal feet of curb has been let to Somerville & Dilworth, 36 Main Street North, Welland.

Norwich, Ont.
The contract for construction of brick pavements has been awarded by the Town Council to Brennan & Hollingsworth, Hamilton. Approximate cost, $10,000.

Port Hope, Ont.
The contract for construction of sewers on King and Slater Streets has been let by the Town Council to Thomas Garnett & Sons, Barrett Street, at $4,978.

Prince Rupert, B.C.
The City Council have let the following contracts for supplies required in connection with the waterworks and power plant now in course of construction: Machinery, Canadian Fairbanks-Morse Company, 510 Johnson Street, Victoria; wood pipe, Vancouver Wood Pipe and Tank Company, 850 Hastings Street West, Vancouver; steel pipe, hydrants, etc., Campbell, Gordon & Co., 1210 Homer Street, Vancouver; pipe fittings, etc., Letson & Burpee, 172 Alexander Street, Vancouver.

St. Thomas, Ont.
The City Council have awarded a contract for construction of concrete pavement and curb to A. E. Ponsford, 605 Talbot Street.

Timmins, Ont.
The Town Council have awarded the contract for construction of concrete sidewalks to Routley & Summers, Haileybury. Approximate cost, $6,000.

Railroads, Bridges and Wharves

Saskatchewan Province
The Board of Highway Commissioners, Regina, will receive tenders until August 7 for construction of a reinforced concrete bridge and concrete abutments for bridges in various parts of the province.

Saskatoon, Sask.
Tenders will be received until August 7 by the Board of Highway Commissioners, Regina, for work on a traffic bridge over the Saskatchewan River, including laying of pavement and street car tracks. Plans and specifications at office of the City Commissioner.

Sherbrooke, Que.
Tenders on the construction of a concrete dam for the City Council will be received until noon, August 11, by the secretary, E. C. Gatien. Consulting engineer, M. A. Sammett, 301 McGill Building, Montreal. City Engineer, Thomas Tremblay. Estimated cost, $50,000. Plans and specifications at office of MacLean Daily Reports, Ltd., 25 Charlotte Street, Toronto.

CONTRACTS AWARDED.

British Columbia Province.
The Canadian Northern Railway have let the contract for railroad construction between Kamloops and Kelowna to the Northern Construction Company, 606 Union Bank Building, Winnipeg.

Franklin, Man.
The general contract for construction of a bridge for the Municipal Council has been awarded to H. Sigurdson, 804 McDermot Avenue, Winnipeg. Approximate cost, $3,700.

Halifax, N.S.
The general contract for alterations to a wharf for Robin, Jones & Whitman, Ltd., Water Street, has been awarded to the Standard Construction Company, Metropole Building. Approximate cost, $5,000.
The contract for repairs to the wharf of T. A. S. De Wolf & Son has also been awarded to the Standard Construction Company. Estimated cost, $5,000.

Kettle Rapids, Man.
The Dominion Government Department of Railways and Canals have awarded the contract for construction of a bridge over the Hudson Bay Railway to the Canadian Bridge Company, Walkerville, Ont. Approximate cost, $350,000.

Macdonald, Man.
The contract for construction of a reinforced concrete bridge over Boyne Ditch for the municipality has been let to H. S. Hodson, Boyd Block, Winnipeg. Approximate cost, $3,275.

Maidstone Township, Ont.
The Township Council have awarded contracts for the construction of concrete bridges to W. G. Taylor and H. Penpraise, care of the Clerk, W. R. Phillips, Essex.

Public Buildings, Churches and Schools

Cap Madeleine, Que.
The School Board will shortly call for tenders on the erection of a school, estimated to cost $3,000. Secretary, Jean Bourque.

Glace Bay, N.S.
The tenders received for the proposed addition to the High School were considered too high, and new tenders will probably be called. Architect, J. Mosley. Approximate cost, $5,000.

Montreal, Que.
A toilet room and kitchen are being built by day labor for the Reverend Sisters of Hotel Dieu, Pine Avenue West, at an approximate total cost of $20,000. Superintendent, F. X. Dufresne, Ville St. Laurent. Stone, steel, and reinforced concrete construction.

Pelham Township, Ont.
Tenders on the erection of an addition to the school will be received until 6 p.m., August 9, by Wilson Kline, Ridgeville, Ont. Architect, T. L. Nichols, Welland.

Ste. Anne Village, Que.
The School Board propose to build a

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Day Labor vs. Contract

THE city of Montreal is still wrestling with the old and vexing question, "to be or not to be" —that is, whether it is better to hand over the construction of the various city works to the mercy of villainous (?) contractors or to run the risks attendant upon the indifferently efficient system generally evidenced in municipal operations. At the present time they are trying out the day labor method under the supervision of the city engineer, who is endeavoring to get as good value for the city as circumstances will permit; but it is not long since we read of the difficulties under which superintendents and engineers in this city labored on account of interference by aldermen and other influential officials, which made it impossible that the construction of public work should be carried on efficiently.

Aside from its political aspect, the elimination of competition, which naturally results when any municipality decides to do its own work, must sooner or later result in higher costs. In the meantime there is no means of checking up whether the cost of any particular work is about right or excessive. The most reasonable course for a municipality to pursue, therefore, if the feeling exists that the contractors' prices are too high, appears to be to place itself for the time being in the position of an independent contractor and submit a tender in competition with the others, taking due care of all the legitimate auxiliary overhead expenses. This scheme has been tried out with success. It acts as a safeguard against possible collusion among the contractors and at the same time retains all the advantages of competition.

Business Training for the Engineer

THE engineer of to-day is a broader man in his activities than the engineer of yesterday. He is occupying continually a more important position in the industrial and business world, and his responsibility is increasing not only in regard to the design and supervision of purely engineering work, but also as a manager, business man and leader in world activities. Many commercial corporations have chosen engineers as their active heads and in many other cases he is regarded as an ultimate authority on the business problems that concern public or private enterprises.

A generation ago this was not the case. His field was not nearly so wide and his activities were more limited. He was not regarded as a person possessing any special business or financial ability. The work which an engineer performed was considered in much the same light as the labor of a workman—a thing subservient to the will and supervision of a higher management, which generally was not able to appreciate the technical details involved.

In recent years the engineer has come, or at least shows signs of coming, into his own. It has been realized that the most satisfactory manager of an engineering concern is one who can combine technical requirements with executive ability. There are but few large constructing or manufacturing concerns in which there is not a highly competent technically trained man somewhere near the top. Again, consulting engineers are often retained to advise financial corporations as to many things involving a knowledge of economics and finance. He must be concerned with such things as the advisability of purchase or construction of certain engineering projects, the relative values from an economic or financial standpoint of a number of schemes, and other similar problems. The engineer's work is connected with that of the business man, the lawyer and the financier, and he would be severely handicapped, did he not look at things from their point of view. The engineer, by virtue of contact with a wide variety of similar conditions and an extensive meeting with men of all types, necessarily possess certain qualifications that especially mark him out for leadership. The engineer, whether as contractor or manager, must not only be thoroughly capable in methods of construction and the use of materials, but must also understand how to handle labor and be thoroughly familiar with business and financial principles and methods.

These requirements serve to indicate that the engineer should possess an economic and business training in such measure as will enable him to meet men

of different points of view on their own ground. This training should, therefore, be well rounded and of such a character as to enable him to deal with the larger affairs in which a knowledge of economics is essential. The widening of the engineer's activity has thus imposed greater responsibility upon him, necessitating a different training in that it is broader and more comprehensive. The opportunity is presented to colleges to broaden their curricula to overcome this need. Engineering courses are still too narrow; they deal too much with technical matters and fail to embrace in a sufficient degree those subjects that will broaden an engineer's mind and enable him to cope with the bigger and more important problems. It is the duty of the technical colleges to realize that the engineer of to-day is also much more—he is a business man.

Value of Industrial Research

On the evening of July 3 the members of Vancouver Branch Canadian Society of Civil Engineers, together with many leading citizens, heard an address delivered in the Board of Trade room by Mr. Arthur D. Little, organizer of the research department of the Canadian Pacific Railway Company. The speaker was introduced by Mr. R. F. Hayward, president of the society, who occupied the chair.

In opening, Mr. Little said his mission in Western Canada was to ascertain if scientific research could not solve some of the problems confronting those who were desirous of developing all resources to the utmost. "Science is nothing more than knowledge at its best. As Huxley has put it 'Science is organized common sense.' It is, as this great war has shown us, the basis of prosperity and power." The speaker pointed out the great need of co-operation between the banks and industrial institutions in the work of developing latent resources of the great West. He recalled that before war broke out a bank in Germany had on its staff no less than fourteen chemists, whose duty it was to look into the feasibility of enterprises with a view to finding out whether or not credit could be extended. Mr. Little next referred to several propositions upon which he had been working for some time with every prospect of success being achieved. These included the commercial uses to which the waste from the production of flax might be put, the manufacture of straw "lumber," and the value of straw as fuel.

Great Waste in the Lumber Industry.

The great waste in the manufacture of lumber was not overlooked, the speaker citing as an example one of the largest lumber mills in the world, where there was as much waste as output. He then showed that from this waste the manufacture of ethyl alcohol, turpentine, and paper could be profitably carried on. He also touched on the question of gasoline, pointing out that the demand for this product was becoming greater than the supply. He thought that the natural gas, as found in Canada, contained too much sulphur to be used in the manufacture of gasoline. He concluded that the time would come when ethyl alcohol would be made to replace gasoline.

Mr. Little also dealt with the question of "dry milk," explaining a process by which milk could be dried and at the same time retain all its ingredients. In this connection he prophesied that in the course of time the manufacture of dry milk would be carried on in Canada as extensively and profitably as that of cheese. Touching on the manufacture of paper, he pointed out that British Columbia, with her great water powers and cheap water transportation east and west, offered unequalled sites for the establishment of large paper mills. In closing, Mr. Little commented on the great opportunities from an industrial standpoint of the West in general and British Columbia in particular.

Engineers Admire Sooke Lake Water System

Mr. Fred C. Scobey, Irrigation Engineer, U.S. Department of Agriculture, visited Victoria early in July to secure data connected with the Sooke Lake water system, the necessary information being furnished by City Engineer Rust.

In explaining the nature of his visit, Mr. Scobey stated that the scope of his work was simply the collection of data bearing on the use of concrete pipe as a water carrier. This was a single phase of a series of research work conducted by the Irrigation Investigations Branch of the Department of Agriculture of the United States Government. It was purely technical, and designed for technical uses by making available as a public aid accurate data such as has hitherto been unavailable. The work was under the immediate head of Dr. Samuel Fortier, who aided the Provincial Government in 1912 in the drafting of the present irrigation district laws in force in this province.

The object of the work was to develop absolute information as to the size and form of pipe best suited to the various purposes for which it is to be used. This is accomplished by making actual field tests with special engineering apparatus. From this data is developed proper formulas for form and construction of all manner of flow lines. Last year the investigation was confined to the use of wood stave pipe. This year's work is to be confined to pressure pipe of concrete construction. It covers every phase of the subject, as exemplified by projects which are now in operation.

Mr. Scobey and his assistant were recently over the big C.P.R. irrigation project in Alberta, and have installed their apparatus so as to be ready to make complete tests as soon as the repairs now in progress there admit putting the system in full operation again. The Sooke Lake waterworks system for the city of Victoria, said Mr. Scobey, was rated among engineers as a pretty piece of engineering construction.

Good Roads Competition in Manitoba

The work of the Manitoba Good Roads' Association in connection with their "drag" competition for earth and gravel roads, has created so much interest in that province and has so fully demonstrated the value of the split-log or other drag in maintaining country roads that the competition during the present year promises to be the keenest on record. When the entries closed on May 15, sixty-nine contesting municipalities had handed in their applications. Fifty-six of these cover gravel roads and the balance earth roads.

Though we have described this competition in some detail from time to time, the interest it has aroused in the province of Manitoba and the good results that have been obtained, appear to justify us in dealing further with it. We are printing below the rules covering the "drag" competition for 1916. These are as follows:—

1. All municipalities and affiliated bodies, active

members of the Manitoba Good Roads Association in good standing, are eligible for entry.

2. Entries must be made with the Secretary not later than May 15th, 1916.

3. Entries must state mileage of road to be maintained under this competition and where situated. Winners of the First Prize in either the earth or the gravel class of last year are debarred from entering the same piece of road in this competition, but are not debarred from entering another piece of road.

4. Each municipality or affiliated body competing must have at least two continuous miles leading clay road or roads or one mile of gravel road kept under these conditions, (See Note above).

5. The competition shall commence on June 1st and continue until freeze up.

6. An amount may be paid by any municipality to contestants for the mileage allotted to them not to exceed $50 for the said season's work.

7. Municipalities competing to furnish contestant with split-log or other drag.

8. Prizes will be donated to individuals keeping the best one or two miles, as the case may be, of road, namely:—First prize, $50; second prize, $30; third prize, $20; fourth prize, $10.

9. That sign-boards showing section of road entered in competition shall be provided by the Association,

Manitoba Good Roads Association

1916 DRAG COMPETITION

NAME OF COMPETITOR

.....

NO. OF ENTRY.....

Date	TIME		REMARKS
	Hours	Mins.	
Total Time			

.....Signature

This card, properly filled in, must be handed to the Secretary at close of competition.

and it shall be a condition of entry that contestants shall place one of these signs at every half mile of the competition stretch and keep same in position during the contest.

10. Judges appointed by the Districts shall make an inspection of the road or roads selected prior to commencement of this competition and twice during the time in which the competition is being held. The final inspection to be on or about September 15th, 1916. The decision of two of them to be final.

The Manitoba Good Roads Association, which inaugurated this competition in 1910 and has carried it on each year since that date, claim to have demonstrated that the inexpensive split log drag is the cheapest and best means of maintaining both earth and gravel roads. They point out that it is wasteful and improvident to have roads built and afterwards find their usefulness lost or decreased to the public through lack of care and maintenance. For this reason the association have undertaken to do everything possible

MANITOBA GOOD ROADS ASSOCIATION

SCORE CARD DRAG COMPETITION, 1916

Description of Road

Name of Contestant Entry No.

Municipality of

	[illegible]	[illegible]	[illegible]
1 Condition of Road prior to Commencement of Dragging	[illegible]	[illegible]	[illegible]
2 Straightness, Width and evenness of grade with proper slope to ditches	[illegible]	[illegible]	[illegible]
3 Drainage	[illegible]	[illegible]	[illegible]
4 Freedom of burm from grass, weeds, brush, stones or other litter	[illegible]	[illegible]	[illegible]
5 Nature of soil	[illegible]	[illegible]	[illegible]
6 Traffic	[illegible]	[illegible]	[illegible]
7 Condition of road surface over culverts	[illegible]	[illegible]	[illegible]
8 Competitors may be penalized if signs are not kept in place [illegible]	[illegible]	[illegible]	[illegible]

Score card - opposite side ruled for 'remarks' of judge.

to assist the government to promote the formation of "good road dragging competitions" in all parts of the province, similar to those which have been confined in past years very largely to the Winnipeg district and which have proven so beneficial in that area.

The dragging of the roads, under the rules of the competition, must continue for the entire season or at least between May 1 and October 31. Each district must arrange for the judging of its own roads.

C.N.R. Terminal at Vancouver

The contract for the erection of the new Canadian Northern depot on False Creek, Vancouver, has been awarded to the Northern Construction Company, of Vancouver and Winnipeg (of which A. K. Mann is president), and Carter, Halls & Adlinger, of Winnipeg. Their tender, the lowest submitted, was for a sum close to $600,000. It covers the depot only, the platforms and freight shed being held for future allotment.

The Northern Construction Company, which has its offices in the Vancouver Block, has already carried out considerable work for the C.N.R., including grading and the laying of tracks all through British Columbia and on the prairies. At the present time they are associated with Carter, Halls & Adlinger in the construction of a large aqueduct at Winnipeg, which will cost in the neighborhood of eleven million dollars. Before the real work of erecting the depot can be commenced there is considerable filling to be done, and this will occupy about two months. In addition, pile driving to the extent of about 120,000 feet has to be done.

Matters at issue between the Hamilton, Ont., electrical contractors and their employes are assuming interesting proportions. The Building Trades Council claim that there exists an association of electrical contractors and, therefore, they are required to abide by the laws of the constitution in the matter of employing strike-breakers. It is anticipated that if the electrical contractors refuse to recognize the statutes of the Building Trades Council a general walk-out of about 2,000 men in the Hamilton building trades will occur on August 7.

The Value of Motors for Street Cleaning

Experiences in Street Sweeping by Mechanically Propelled Vehicles—Economical and Efficient—Heavier Loads, Longer Trips and Fewer Stoppages

By W. Greig*

I propose giving a brief resume of our experience in Glasgow in the realm of street sweeping by means of mechanically propelled vehicles, the motive power of which is derived from the internal combustion engine, the fuel used being petrol.

I have not the slightest doubt that some of the conclusions we in Glasgow have arrived at in this comparatively new sphere of our work will be challenged by my friends here; indeed, I hope it may be so, for only by such means can we hope to gain knowledge, and my object is as much to elicit fresh ideas and information for the benefit of us all as to endeavor to convey to you some results of the large and varied experience the Glasgow Cleansing Department has had in this connection.

In laying claim to this large and varied experience it is hardly necessary for me to remind you of Glasgow's population, size and extent. Our city area is 30 square miles; the streets extend to 475 miles; and our inhabitants number 1,075,000.

The streets are principally laid with whin or granite setts, comparatively few being smooth paved. There are, of course, a number of macadam roads.

Our first motor street-sweeping machine started work on September 11, 1912, and since then the number has been increased from time to time, until at present the department owns twelve motor street-sweeping machines—viz.: six 18-h.p. by the Lacre Motor Company, Letchworth; five 12-h.p. by M. Laffly, Boulogne-sur-Seine; one 16-18-h.p. by Thomas Green & Sons, Leeds.

All the machines are driven by live axle, with the exception of the "Lacre" vehicles, which are chain-driven. All are fitted with rubber tires. The length of the brushes varies from 6 ft. to 7 ft. 2 ins., and the actual width swept ranges from 4 ft. 10½ ins. to 5 ft. 4½ ins. In the case of the Laffly machines the brush is all in one piece (7 ft. 2 ins. in length), but in the other types it is made up of segments measuring approximately 16 ins. in length. With one exception the machines are equipped with water tanks having a capacity of 80 to 150 gallons, from which the water is sprayed under pressure by means of atomisers. The vehicles are also fitted with "cabs" and adjustable wind-screens to protect the driver during inclement weather—an advantage which he no doubt appreciates when contrasting his lot with that of his colleague on the horse-driven machine. These are the chief features of our motor-sweepers, but I shall be pleased to supply anyone interested with a full specification should he desire it.

When the introduction of mechanically driven vehicles in place of horse-drawn vehicles was under consideration in Glasgow, the two points which had to be carefully borne in mind were our old hard-worked friends "economy" and "efficiency." These are vital factors—not only in cleansing work, but in all work.

As regards economy, it is recognized that the most profitable work for petrol-driven commercial vehicles is that which involves (1) heavy loads; (2) long journeys; and (3) few stoppages—as short as possible. In cleansing work, motor street-sweeping machines approach most nearly to these ideal conditions, and this, I think, has been demonstrated in every town which has introduced such machines.

The journeys are long, the stoppages few and short, whilst the load—the area swept in this case—is greater than in horse-drawn machines, and this should be the greatest possible consistent with speedy working, taking into consideration traffic conditions, running costs, and wear and tear of machines. It is not surprising, therefore, to find that the unanimous opinion of those who have used motor sweeping machines is that they are, from an economical point of view, a pronounced success. I am able to show, from the tabulated statements submitted with this paper, that the results obtained in Glasgow as compared with horse-drawn vehicles are all in favor of mechanical sweeping.

As to efficiency, the general consensus of opinion is that motor street-sweeping machines do the work of sweeping quite as well—possibly rather better than horse-drawn sweeping machines. There may be superintendents and others who hold the view that horse-drawn machines do the work better, but I am of opinion they are in the minority. I am afraid that those who maintain that the motor street-sweeping machine does not perform its work efficiently are swayed to some extent by prejudice. I am assuming, of course, that the motor sweeper is operating under good working conditions. It is the case that the motor sweeping machine, when the brushes are nearly worn out, may not give as good results during the last half shift when the brush is in reality too short for satisfactory work. This is due to the fact that the first half shift of the last day's work has worn the brush to that point. It must be borne in mind that a motor sweeper traveling over six miles per hour wears out the brush in a much shorter time than a horse-drawn machine, and therefore a half shift in a motor sweeper makes an appreciable difference in a brush, whereas in a horse-drawn machine it is insignificant.

One Advantage of Horse-Drawn Machine

This is one of the few points in which the actual conditions suit the horse-drawn machine better than its rival and enable it to show in a favorable light—it sweeps well to the end of the line of the brush. But this adverse criticism of the motor vehicle only applies to machines working during the night, or at a considerable distance from the depot during the day. If working during the day within reasonable distance from the depot, the worn-out brush can be taken out and replaced. With machines working during the night, or at a considerable distance from the depot during the day, the unsatisfactory work can be reduced to a minimum by working the machines in teams of three or four, utilizing the machine with the shortest brush to perform the first stroke throughout the sweeping operations.

A special feature of the motor sweeper which is worthy of mention is the water tank and atomizer. In sweeping operations during dry weather it was formerly necessary to water the streets in advance

* Cleansing Superintendent, Glasgow, before Annual conference of Cleansing Superintendents.

of the machine. By the introduction of the water-spraying apparatus on the motor sweeper the time of the horse and man with the watering cart is saved. The state of the surface of the streets is frequently such that smooth-paved streets require watering, whereas streets laid with setts do not need damping. Under these conditions the atomizer shows to advantage. It also frequently happens in this variable climate of ours that in the middle of the advance watering operations one or more good showers cause the water cart to look ridiculous, and the work of the horse is rendered superfluous so far as the area watered has not been swept before the rain came on. How favorably the atomizer shows up under such circumstances is obvious. The only difficulty experienced with the spraying apparatus is that it chokes readily with glut, or fine dust or grit, and consequently requires constant inspection and cleaning. In fact, in Glasgow, and, I understand, some other places, it has been necessary to increase the mesh to meet this objection, at the sacrifice of extra time lost in filling the tank more frequently.

TABLE OF COSTS

Working Costs of Motor Sweeping Machines for Year Ended 31st May, 1916

Time—Working days	1,895
" Actually sweeping, hours	14,846
" Average number of hours sweeping per day	7.83
Total distance travelled to and from sweeping points	8,330
Mileage swept ....Total	89,393
Mileage swept per day ....Average	47.17
Mileage swept per hour ....Average	6.02
Area swept, square yards ....Total	275,814,954
Area swept, square yards ....Daily average	145,530
Area swept, square yards ....Per hour	18,578
Motor spirit:—	
Total quantity, gals.	9,811
Total cost	£585 15 5
Miles per gallon, including travelling	9.96
Miles per gallon, less travelling	9.11
Cost per mile, including travelling	1.44d
Cost per mile, less travelling	1.57d
Drivers' wages	£599 11 11
Repairs, cleaning and supervision	505 5 4
Motor spirit	585 15 5
Oil, grease and sundries	90 5 0
Brushes, including cost of fitting	813 5 8
Tires, upkeep of	135 19 10
Insurance	76 12 6
Depreciation (20 per cent. per annum)	694 4 0
	£3,500 19 8
Cost per 1,000 sq. yds. swept, including repairs	3.05d
Cost of brushes per 1,000 sq. yds., swept, including repairs	.71d
Saving compared with horse-drawn machine	£1,321 12 3

Another advantage of considerable value to be obtained from the use of motor sweeping machines may be mentioned here. It is the working of these machines in double shifts. In large towns, where much sweeping falls to be done, and traffic and other conditions permit of its being partly performed during the day, the saving to be effected is too obvious to require further comment. That is, of course, provided always that day cleansing is approved. This is, I am aware, a matter of opinion, but in any case it is outside the scope of this paper.

In submitting statistics of the running costs of our motor sweeping machines, I would like to say that I do so without intending to set up a comparison with the results obtained in other cities and towns, whether more economical or otherwise. Speaking generally, comparisons of costs between one place and another are fruitful of error and misunderstanding, and the reasons are not far to seek. It would be difficult to find two industrial centres in which there exists anything like equality of conditions. The volume of traffic and the proportion of area to population differs almost everywhere. Then again, the topographical and climatic conditions and the nature of the surface of the streets—which in conjunction with the extent of traffic largely determine the cost of street cleansing—are generally dissimilar.

It is only to be expected that better results will be obtained in towns where good sweeping conditions generally exist than in places not so well favored. In Glasgow the density of population, the vastness of industry, and the great volume of traffic, render the conditions undoubtedly severe. The material to be removed is greater than in the same mileage of streets with equally good surfaces, but under different conditions as to population, industry and traffic. The state of the dirt and its adherence to the surface is determined by the amount of traffic over it, and the prevailing weather conditions. I should think that these drawbacks are more in evidence in Glasgow than in most towns. The condition of the surface—paved or otherwise—is a factor of great importance. Fortunately, in Glasgow there is no reason for complaint in this connection. A vast improvement has been effected during the last dozen years, and the condition generally is very good. The continued laying of smooth impervious paving and the gradual abolition of macadamizing is assisting greatly in this direction. It is therefore evident that inferences drawn from comparisons between places that are not comparable can not have any real value.

Work in English Towns

While speaking of comparing results in different places, it may be pointed out that the amount of sweeping done by a horse-drawn machine in Glasgow is approximately seventeen miles of track. In English towns this length is never, to my knowledge, reached, and is generally given as about twelve miles. The effect of this circumstance on comparisons is clear. Motor sweepers may be doing exactly the same amount of work in two different towns, and yet in the one be doing the work of three horses, and in the other the work of four. A bald statement that a motor sweeper is doing the work of so many horses in "A," and displacing so many in "B," is, it will be agreed, valueless for the purposes of comparison.

It follows that the standard of horses engaged in street sweeping has a distinctive bearing on the question of comparative cost as applicable to mechanical haulage. In this connection I am of opinion that in Scottish towns the greater amount of work performed can only be explained by the fact that horses of the Clydesdale breed are employed as against those of the "Shire" type in England.

I had the privilege of visiting an English town quite recently, and as the result of personal observation of horses engaged at cleansing work, I have no hesitation in stating that our horses overtake from 50 to 75 per cent. more work than in the town referred to.

In some towns in England it is claimed that a

motor sweeping machine performs the work of three horse-drawn vehicles, and in other places the machines are said to displace six to seven horses. We have not yet attained the latter displacement, but as near as possible one motor sweeper in Glasgow is overtaking the work of three horses. While this is satisfactory as far as it goes, and is undoubtedly more economical than horse-drawn vehicles, one must not, in comparing mechanical haulage with that of horses, run away with the idea that all the advantages are on the side of the first-mentioned. The bulk of them do lie with it and give it claims which fully justify its preferment, but there is something to be said for our tried and faithful servant the horse—still holding its own in many branches of cleansing and other work. I refer particularly to its mobility, and this, along with reliability, constitute the most important points in its favor. During climatic changes, or for other reasons, it can be transferred on the shortest notice to do any class of work of a haulage nature.

I will illustrate my meaning. Suppose a severe snowstorm in winter takes place, every available horse has been taken from refuse removal and other work and is fully occupied in the removal of snow. Immediately the snow has been removed frost sets in, rendering street sweeping of little avail on account of the hard surface. In that event sweeping may be almost entirely suspended, and the horses put to forward the work which had been stopped through the snowstorm. There are other periods of the year when this interchangeability would prove extremely advantageous and economical. A motor sweeper can only do the sweeping. This is a point of paramount importance to smaller towns; even in larger towns where the major part of the sweeping, say eighty per cent., is performed by motor vehicles, it may still be expedient to reserve the remainder for horse-drawn machines.

Important Points

To get the best work out of a motor sweeping machine it should be worked on long stretches, with as few turns as possible. This entails the working in teams of three or four machines, according to the width of streets to be swept, in order to allow the work of gathering and removal to proceed expeditiously. Another advantage is an appreciable saving in front tires. The turnings are invariably in the shortest radius, and when frequent the grinding action is very detrimental to the tires.

It is essential that the mechanical parts of the machine should be kept in the best of order. An annual overhaul, even if no fault discloses itself, is to be recommended, and I would therefore advocate that there should be at least one spare machine in a fleet of ten to twelve machines.

The drivers should be selected with the greatest discrimination with regard to skill and care and interest in their work. During war time this is difficult—in fact, impossible—and in Glasgow the results are reflected in the loss of working days and the repairs bill. An alert and intelligent foreman can assist the work of exercising close supervision, planning of work and judgment of conditions from night to night. Weather conditions vary greatly, thus quickly affecting the state of the surface of the streets. This in turn determines the pressure of the brush on which, to a large extent, the petrol consumption, the life of the brush, and other wear and tear of the machine depend. A careless foreman or unobservant driver would negligently keep the brush at the same pressure on the surface of a street that is hard and dry, as for one of a pasty nature. Regulation of pressure is absolutely necessary in the interests of economy.

At this juncture I would offer the suggestion that in normal times considerable advantage would be derived from a series of lectures and demonstrations by motor experts to drivers and foremen.

A Word to Manufacturers

Perhaps a word to motor manufacturers may not be amiss. They should not rest on their oars under any misapprehension that their product is the last word in sweeping machines. They should, and I believe will, devote their closest efforts to bring the machine to a greater degree of perfection, particularly with regard to reliability. The unreliability of the machines may be due to one or more of the following reasons: (1) defective design; (2) bad workmanship or material; (3) rough usage; (4) negligence in attention to repairs, more especially of the "stitch in time saves nine" character. The first lies with the experts and there is no excuse for the second. With regard to the third and fourth these are the concern of the users, but at the same time the makers can help their customers very materially in these respects, and it is to them I would direct their special attention. Rough usage and careless handling are always worrying all users of motor vehicles, and improvements in design with a view to greater stability and to making the machines "fool-proof" as nearly as possible are greatly to be desired. Repairs and breakdown at awkward times are sources of much annoyance and inconvenience. Improvements in design making for greater facility of continual inspection, and speed and simplicity in carrying out the necessary repairs, would save much loss of time, not to mention temper, and would approach the ideal which cleansing superintendents are striving for in this as in every other department of their work.

In conclusion, I may say that I feel honored in being asked to appear before you and give you, as a corporate body, the benefit of our experience in Glasgow in regard to this branch of mechanical enterprise. I quite realize that it is only by making ourselves helpful to one another—even at the risk of well merited criticism—that we can become more serviceable to our respective corporations. To be harnessed with the responsibility of cleansing great cities and towns must of necessity make cleansing superintendents ever on the alert for ideas suggestive of improvement, in order that we may make steady and continuous progress in our important sphere of municipal work. To a great extent we are responsible for the health and comfort of the citizens, and in our effort to impart sweetness and attractiveness to our streets, I make bold to say that, speaking generally, our army of ratepayers are receiving better value for their money than they have ever known. For much of our advancement we have in no small measure to thank our connection with the Institute of Cleansing Superintendents, and I am of opinion that, in view of the rapid progress of inventive genius, it would be well if corporations were more generous in affording to members of committee and officials greater opportunity of seeing for themselves what is being done in the principal cities. The expenditure involved would in all probability be more than repaid by the introduction of methods leading to economy and efficiency, and at the same time assist even a cleansing superintendent to excel in a calling which, to a certain extent, is shrouded in an obscurity which never darkens the portals of less important but more attractive branches of municipal work.

The Thickness of Flat Concrete Floor Slabs

A Theoretical Discussion Bearing on the Depth of Reinforced Floors — Geometrical and Mechanical Treatment Impossible

By Henry T. Eddy:

THE correct thickness of a reinforced flat slab depends not only upon the distance between centers of supports and upon the design load, but upon the diameter of the column cap and upon the steel ratio in such a complicated manner that it is impossible for it to be determined directly from geometrical and mechanical considerations, especially in view of the fact that the resisting moment of the steel is the product of the unit stress times the cross section of the reinforcing steel multiplied by its arm, and either of these last two factors may consequently be varied at the expense of the other without varying their resisting moment.

It is highly desirable therefore to employ some empirical formula for the thickness of the slab from which a value may be obtained that is based on such a wide range of successful construction as to give confidence in its reliability, and that at the same time is as simple as possible.

In the foregoing statement it is implied that it is quite possible to design slabs of different thicknesses for the same span and design load and yet so proportion them that they will all have the same strength. Their stiffness will, however, be different, and some of these designs will be more economical than others. Balanced reinforcement will not necessarily nor probably furnish the most economical design, nor one that is the stiffest, nor one that is the most advantageous from every point of view.

As a general principle it is advisable to have the slab so designed that the concrete in the compression zone is stronger than the steel in the tensile zone, because the steel has more definite and better known properties than the concrete, and in case the steel is the weaker element, since the strength of any structure depends upon its weakest element, the strength of the slab may then be known with certainty, because it will depend upon the properties of such a dependable element as the steel and not upon an unreliable and fragile material like concrete. This will require that the slab be under-reinforced and not over-reinforced.

Perhaps the most dangerous fallacy common respecting flat slabs is in making the assumption that it is advantageous to so greatly increase the percentage of steel as to cause over-reinforcement, a thing that is easy to do, since slabs require only about half the percentage of belt reinforcement needed by beams.

This principle of under-reinforcement fixes an upper limit to the permissible or available steel ratio in slabs, which in turn fixes their minimum thickness in a manner similar to the minimum thickness of beams as has been determined in our treatise on Concrete-Steel Construction, page 86.*

It has been found that a formula for the effective thickness d and the total actual thickness h of a flat slab which will express the values of these quantities in inches with great accuracy is of the following forms, viz.:

$$d = h - a = L' (w_s + b) c$$

In this L′ = the span from centre to centre of supports in feet; w_s = the total design working load in pounds per square foot; a = the mean vertical distance at mid span in inches from the centre of action of the steel to the bottom of the slab, assumed as ⅞ in. = 0.875 for reinforcement consisting of ⅜ in. round rods, and as 1 in. for ½ in. rounds while b and c are constants determined so as to adjust the formula to safe practice. It will be observed that w_s in the formula is the working live load per square foot at any span whatever and b and c are so determined that L′, w_s and h or d in the formula may be regarded for graphical purposes as co-ordinates of a ruled surface in which, if L′ and w_s be used as rectangular co-ordinates in a horizontal plane, h or d is the vertical distance or ordinate of the surface above that plane, but the plane from which d is measured is ⅞ in. above that of h. This surface is an elementary doubly ruled surface known as a hyperbolic paraboloid in which at any given or assumed value of L′ the thickness h increases uniformly with w_s, and at any given value of w_s the thickness increases uniformly with L′. Using convenient approximate values of a, b and c for ⅜-in. round reinforcing rods the formula may be written in the following form:

$$h = 0.87 + L' (w_s + 700) / 2500 \quad \ldots\ldots\ldots (1)$$

in which h = the total thickness of the slab in inches, and L′ = the distance in feet from centre to centre of supports of a square panel, while w_s = the working live load per square foot of panel in pounds.

The manner in which the numerical values of b and c given in (1) were obtained by calculation from any two known thicknesses when once the general form first given had been assumed is as follows:

It is known from experience that for a 17-ft. panel and a design live load of 200 lb. per square foot h = 7 in. nearly, and for a 23-ft. panel and a design live load of 400 lb. per square foot h = 11 in. nearly. Hence the general formula for these two loads and these spans reduces to

$$7 = 0.87 + 17 (200 + b) / c$$
$$11 = 0.87 + 23 (400 + b) / c$$

Hence, b = 700 and c = 2,500 nearly. Formula (1) may also be written in a form convenient for calculation as follows:

$$h = 0.87 + 0.0001 L' (4w_s + 2,800) \quad \ldots\ldots\ldots (1)_a$$

In Table 1 are given the numerical values of the thickness h for various spans L′ from 14 to 32 ft. and various live loads w_s from 80 to 600 lb. per square foot calculated in accordance with formula $(1)_a$. The work of calculating this table is greatly facilitated by noting that for any given value of L′, h varies as w_s, and for any given value of w_s, h varies as L′; that is, there is a constant difference in the values of h per hundred pounds along any given horizontal line and a constant difference per foot of span down any given column of the table.

The values of h given in Table I agree closely with the values of the design thickness given in the standard tables employed for Mushroom slabs from which the floors of more than 2,000 buildings have been successfully constructed, but the values in Table I are very slightly in excess of those found in these standard

:Professor, University of Minnesota in Engineering and Contracting

*Eddy and Hurner, Minneapolis, 1914.

TABLE I.—TOTAL THICKNESS h OF ROUGH SLAB WITH ⅜-IN. ROUND RODS.

$h = 0.87 + (4\ Wo + 2800)\ L'/10^4 = 0.87 + d$ inches

L' = span in feet. Wo = live load in lb. per sq. ft.

L' = ft.	Wo=80.	100	125	150	200	250	300	350	400	450	500	550	600
14 x 14	5.24	5.35	5.49	5.63	5.91	6.19	6.47	6.75	7.03	7.31	7.59	7.87	8.15
15 x 15	5.55	5.67	5.82	5.97	6.27	6.57	6.87	7.17	7.47	7.77	8.07	8.37	8.67
16 x 16	5.87	5.99	6.15	6.31	6.63	6.95	7.27	7.59	7.91	8.23	8.55	8.87	9.19
17 x 17	6.18	6.31	6.48	6.65	6.99	7.33	7.67	8.01	8.35	8.69	9.03	9.37	9.71
18 x 18	6.47	6.63	6.81	6.99	7.35	7.71	8.07	8.43	8.79	9.15	9.51	9.87	10.23
19 x 19	6.80	6.95	7.14	7.33	7.71	8.09	8.47	8.85	9.23	9.61	9.99	10.37	10.75
20 x 20	7.11	7.27	7.47	7.67	8.07	8.47	8.87	9.27	9.69	10.07	10.47	10.87	11.27
21 x 21	7.43	7.59	7.80	8.01	8.43	8.85	9.27	9.69	10.11	10.53	10.95	11.37	11.79
22 x 22	7.74	7.91	8.13	8.35	8.79	9.23	9.67	10.11	10.55	10.99	11.43	11.87	12.31
23 x 23	8.05	8.23	8.46	8.69	9.15	9.61	10.07	10.53	10.99	11.45	11.91	12.37	12.83
24 x 24	8.36	8.55	8.79	9.03	9.51	9.99	10.47	10.95	11.53	11.91	12.39	12.87	13.35
25 x 25	8.67	8.87	9.12	9.37	9.87	10.37	10.87	11.37	11.87	12.37	12.87	13.37	13.87
26 x 26	8.99	9.19	9.45	9.71	10.23	10.75	11.27	11.79	12.31	12.83	13.35	13.87	14.39
27 x 27	9.30	9.51	9.78	10.05	10.59	11.13	11.67	12.21	12.75	13.29	13.83	14.37	14.91
28 x 28	9.61	9.83	10.11	10.39	10.95	11.51	12.07	12.63	13.19	13.75	14.31	14.87	15.43
29 x 29	9.92	10.15	10.44	10.73	11.31	11.89	12.47	13.05	13.63	14.21	14.79	15.37	15.95
30 x 30	10.23	10.47	10.77	11.07	11.67	12.27	12.87	13.47	14.07	14.67	15.27	15.87	16.47
31 x 31	10.55	10.79	11.10	11.41	12.03	12.65	13.27	13.89	14.51	15.13	15.75	16.37	16.99
32 x 32	10.86	11.11	11.43	11.75	12.39	13.03	13.67	14.31	14.95	15.59	16.23	16.87	17.51

tables for large spans and heavy live loads.

It seems desirable to prescribe a minimum thickness of h = 6 in. which should be adopted in practice in place of the few slightly smaller values computed in Table I.

In case of rectangular panels the span of the longer side of the panel is that designated by L', for, the thickness of a floor consisting of rectangular panels not square should be the same as that of a floor of square panels having the same total load and the same span as the longer side of the rectangular panels, because for the same load the bending moments across the belt on the longer side will be the same in both cases and further the thickness should be governed by the moments at mid-span across this side rather than by those across the shorter side, since they are the larger.

In order to compute the dead load of the slab per square foot assume that reinforced concrete weighs on the average 150 lbs. per cubic foot or 150/12=12.5 lb. per inch of thickness per square foot of slab. The dead load w_1 per square foot consequently may be calculated from h the thickness in inches as follows:

$$w_1 = 12.5\ h = 100h/8 \quad \ldots\ldots (2)$$

The value of w_1 for the several thicknesses already computed is readily calculated by (2) and tabulated. The value of the total load is therefore—

$$w = w_0 + w_1 \quad \ldots\ldots (3)$$

which is the sum of the live and dead loads per square foot of slab. This may also be readily tabulated for the same live loads and spans as in Table I. Tabular increments for (2) or (3) are constant for equal increments of L' or w_0.

A formula for the minimum thickness of flat slabs different from (1) has recently been proposed in the new ruling on the design of reinforced concrete flat slab floors in the city of Chicago, as follows:

$$h = .032L'\sqrt{w} \quad \ldots\ldots (1)_2$$

in which L', w and h have the meanings already defined in equations (1) and (3), except that L' is "defined as the average distance centre to centre of columns of the long and short sides of a rectangular panel."

It is somewhat tedious to compute values of h by this formula $(1)_2$ because the dead load depends upon the thickness which is to be computed, a fact which necessitates repeated trials to find h, a difficulty avoided in equations (1) and $(1)_1$. If, however, a table of values of h be computed from $(1)_2$, like Table I, it will be found that the values of h so computed which lie on a diagonal line across the table from the lower left-hand corner where L'=32 and w_0=80 to a point on the upper line where L'=14 and w_0=400 are nearly identical with those in Table I, but that $(1)_2$ gives values of h that are increasingly larger than those in Table I the nearer they lie to the lower right-hand corner of the table. At L=32, w_0=600, the value of h so computed would be nearly 22 in. instead of 17.5 in. as given in Table I, and at L'=32 and w_0=400 the value of h would exceed that in Table I by more than 3½ in.

Again $(1)_2$ gives increasingly smaller values of h than those in Table I for all points which lie nearer the upper left-hand corner at L'=14 and w_0=80, at which point the difference amounts to more than 1-1/3 in.

But these last excessively small and inadmissible values of the thickness are taken care of in the Chicago ruling by a special blanket clause providing that "in no case shall the slab thickness be less than one thirty-second (1/32) of the panel length for floors, one fortieth (1/40) for roofs, and also not less than 6 in." This last clause would need to be applied to all points of a table of values for h computed by equation $(1)_2$ between the upper left-hand corner and a diagonal line drawn from L' = 22' and w_1 = 80 lb., to L' = 14' and w_0 = 300, while the clause requiring h greater than L/32 would apply to all points in the table where w_0 is less than 200 lbs. approximately. Any ruling in which the exceptions cover so large a part of the usual run of buildings evidently cannot be regarded as having any scientific or theoretically correct basis.

It is stated, however, in the paper previously referred to that $(1)_2$ is based on an accumulation of test results in the office of the Chicago Building Department from which the data respecting 10 selected buildings are tabulated. It seems desirable to compare the actual thicknesses h of these 10 selected slabs with the thickness h_1 calculated according to $(1)_1$ and the thickness h_2 according to $(1)_2$, as shown in the accompanying table. The values of h_2 as given are only approximate and are based on a dead load due to a thickness h. They are consequently all except No. 9 somewhat larger than would be obtained by a more

exact calculation. It is evident that so far as these thicknesses are concerned which were specially selected to support $(1)_2$ they are more nearly in accordance with $(1)_1$ than with $(1)_2$.

Building	h_1	h_2	h_3
1. Lyon & Healy	7.5	8	7.1
2. Ill. Wall Paper	8.5	8.4	7.5
3. Ed. Katzinger	8	7.4	7.4
4. Sears-Roebuck	8	7.4	7.2
5. Adam Schaaf	8	7.4	7.2
6. H. Exp. & Van.	6.5	6	4.8
7. Am. Book Co.	10	8.6	9.2
8. Int. Register	7.5	6.2	6.5
9. Donnelly	11	10.8	11.8
10. Ford Motor	11	10.4	10.3

The same is true of the data contained in a table of buildings built on the Acme System given by Mr. Condron of Chicago, the designer of two-way flat slabs, tabulated in a paper by him on page 8 of the Western Contractor, Kansas City, March 12, 1913, in which the deviations of the actual thicknesses from the values calculated by $(1)_2$ are very striking, while the values calculated by $(1)_1$ are mostly in good agreement with the thicknesses of the slabs as actually built. So far as can be seen from these comparisons $(1)_1$ accords much more closely with accepted practice than does $(1)_2$. For large spans and heavy loads the divergence of $(1)_2$ and $(1)_1$ is relatively so large as apparently to make thicknesses computed according to $(1)_2$ prohibitive by reason of the large useless additional dead load called for.

There are three criteria according to which judgment may be passed upon the correctness of the thicknesses as above computed.

One of these has already been mentioned, namely, good agreement with a wide range of common practice, which would usually be regarded as an ample and sufficient basis for an empirical formula, and in fact is the only basis adduced in favor of the Chicago Ruling, but as has been shown the agreement in that case is not so good as is desirable.

The second criterion is that the thickness shall not be so small as to produce undue compressive stresses in the slab nor require an unduly high percentage of steel. The fulfillment of this second criterion depends upon the existence and validity of a complete analytical theory of the stresses in flat slabs such as the present writer has developed elsewhere, by which thickness as above computed has been found sufficiently large to fulfil all requirements of this nature.

The third criterion requires that the thickness shall not be so small as to allow deflections that are prohibitive from a structural or practical standpoint. It has been found that all requirements of this kind are also fully met by the thickness as above computed.

Buying Coal on a Heat Unit Basis

By R. O. Wynne-Roberts*

THE present movement in almost all lines of business activity is to adopt more scientific methods. The war has established this in our minds and it remains to be seen if the severe lesson will be effectual and lasting.

We buy wheat according to the government standard of grading; no merchant would accept a carload of wheat without adopting the best recognized tests. The iron founder buys iron according to a certain standard. Engineers specify the composition, quality and strength of Portland cement. Lime is standardized according to the quantity of calcium oxide it contains. Even sand is often specified in America to be of a certain effective size and to conform to a prescribed co-efficient of uniformity. Electrical materials must comply with certain rigid standards. Paper must be of a particular weight, strength and quality. But coal, which is, often, a large proportion of the working expenses of an undertaking, is usually purchased without any specified standards as to quality; the commercial name is generally accepted although it is often a misnomer.

Coal is consumed in large quantities in Canada for industrial and heating purposes. The consumption in winter time must form a valuable source of revenue to the railway and steamship companies as well as the merchants, dealers and carriers, who are engaged in the coal business.

As coal is consumed to produce heat, it seems rational that heat should constitute the basis of its purchase. This is what is being done by the United States Government for all its departments, by the municipal and educational departments of Chicago and by large industrial companies of America. It is also the basis of contract for a large number of British companies. The Swiss Government have adopted the principle for the purchase of coal for New State Railways and other European countries are buying coal on contracts based on heat unit tests.

Many engineers still contend that the real practical test of coal is the quantity of steam it produces. There are, however, so many conditions which can be varied and so much depends on the men, that it is not the most reliable test, and moreover, it would not be possible in ordinary heating plants. The testing of coal on these lines after accepting delivery of the same often ends in recriminations and criticisms which lead to no satisfactory conclusion.

The testing of coal for heat units, ash and moisture is recognized by engineers, and it seems unnecessary to discuss the question. Yet, whilst its recognition is general, its practice is not so. The reasons for this apparent anomaly are probably due to indifference, trouble, lack of facilities, or the cost. The value of the tests has been proved, for the Chicago Educational Department are reputed to save $100,000 per annum since the adoption of this scientific system.

The United States departments test coal to ascertain the heat units and the quantity of ash content. The contractor bids a price per ton and stipulates the B.t.u. and percentage of ash. If the tests prove that the coal contains a more or less percentage of heat units than the guarantee, additions or deductions are made in the same proportion. If the coal contains 1 per cent. less ash, then a premium of 1 per cent. is added to the contract price. If the coal contains up to 2 per cent. more ash, no deductions are made, but when over 2 per cent. more ash is present deductions are made.

This principle, although simple, is not generally accepted by other consumers of coal. The more gen-

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eral basis is to include the moisture content in the calculations.

The contractor offers to supply coal at a certain price and at the same time he states the heat value, ash and moisture contents. In other words, he offers to supply a definite number of heat units for one cent.

The specification stipulates how the coal is to be tested and how the contract price will be affected by the variations from the guarantee. The following formulas will show how this method operates.

$$(1)\ Cg = \frac{[H-(H\times M)]\times 2000}{P+AP/2} = \frac{2000\,H\,(1-M)}{P+AP/2}$$

$$(2)\ Dv = \frac{[H-(H\times M)]\times 2000}{Cg} - \frac{AP}{2}$$

Where

Cg=Contract guarantee, or heat units for one cent.
Dv= Value of delivered coal in cents per ton.
H= Heat units in one pound of dry coal.
M= Moisture percentage expressed in decimal, for example, 5 per cent. equals .05.
A= Value of percentage of ash.
P = Contract price per ton expressed in cents.

If the contractor quoted, say, $6.00 per ton and guaranteed 12,500 B.t.u. per lb., 6 per cent. moisture and 7 per cent. ash, then formula (1) would result in

$$Cg = \frac{2000 \times 12500\ (1-.06)}{600+(300\times .07)}$$
$$= 37{,}842 \text{ heat units for one cent.}$$

Suppose the coal only gave 12,200 B.t.u. per lb., the ash was 8 per cent. and the moisture 5 per cent., then the formula (2) would be

$$Dv = \frac{2000 \times 12{,}200\ (1-.05)}{37{,}842} - \frac{600 \times .08}{2}$$
$$= 612.5 - 24$$
$$= 588.5 \text{ cents per ton.}$$

The following are some of the advantages of buying coal on the heat unit basis: The contractor knows what he has to do and also knows that the tenders are easily and satisfactorily selected. The aldermen can see at once that the cheapest coal is that which furnishes the greatest number of heat units for one cent. The method is conducive to greater competition among the contractors because they know that tenders will be accepted according to merit; the Chicago Educational Board usually had three or four bids for coal supply, but when the heat unit basis was adopted, the number of tenders increased immediately to 20. The price fixed is based on the quality of coal supplied and therefore it acts as a check on the colliery and coal merchant. It further has the effect of inducing the coal agents to supply the coal or the mixtures of coal which will give the best results, and, knowing that tests are being made frequently, the quality of coal must be maintained. The consumer is protected inasmuch as he pays for the service rendered and not for a name which may be misapplied. It was found in Hamburg that one result of coal testing was a great abatement of the smoke nuisance.

The general adoption of the above system of coal testing and payment by results will constitute a very important step along the lines of efficiency and economy.

Irrigation Systems, Methods and Structures

Preliminary Investigations that Are Required Before Installing an Artificial Watering Scheme—Types of Reservoirs and Works

Irrigation refers to the watering of farm land by the employment of artificial methods. It involves a systematic application of water with the object of promoting present or prospective growth, its purpose being to assist the means of nature, or in arid and semi-arid regions to provide the moisture necessary to make land fertile. Agriculture by this method produces most abundant and luxuriant crops, since water is provided only when needed and always in exactly the amount required. In artificial irrigation, there is involved an easily regulated, uniform treatment of farm soil. For intensive cultivation, an artificial supply of water, abundant in quantity and uniformly distributed, such as irrigation provides, is necessary for the forcing of the growth, and by this method two or more crops can be arranged per season.

In watering land by artificial means, ditches are constructed, which lead from the source of supply and are so aligned and graded that the water flows through and from them into minor channels and from them, in turn, to further distributary channels, leading finally to the field, by means of ploughed furrows or otherwise. Irrigation systems require a great deal of skill in their design, in order to employ methods whereby the water may be applied in the easiest, least expensive and most surely uniform manner, which is by the action of gravity and natural flow. A study of an irrigation project involves a careful and exact analysis of hydrographical data, in order to determine the character and volume of the source of supply and its suitability for the work required. Careful examination must also be made of the land conditions, to develop the correct alignments and grades.

Irrigation propositions have been well developed in the Canadian West and in the western United States by railway companies, the respective governments and private corporations. The climatic conditions in this locality are such as to warrant irrigation schemes. Rain is irregular and very dry seasons are experienced, but the soil is of such a character that productive and abundant crops result from the application of moisture by artificial methods.

Hydrographical Data

In planning any irrigation project, the first undertaking is to determine whether sufficient water is available. This requires hydrographical investigations to obtain full information regarding precipitation, run off, and stream flow.

Precipitation

Precipitation or rain fall is a governing factor in the supply of water available for irrigation purposes, where soil and climate are favorable to the growing of crops. An estimate of the probable future rainfall

must be made after a careful examination of the past records of precipitation in the locality extending over a number of years. If precipitation is known to vary appreciably from year to year, it is wise to base the estimated future rainfall on minimum values in computing an available irrigation supply. It is necessary, though, to make the design of structures sufficiently strong to withstand the maximum precipitation which may occur.

Run-off

The run-off from a watershed is water that flows in streams draining the watershed. Run-off from a catchment area may be expressed in two ways—either as the number of second-feet of water in the streams draining the area, or as the number of inches in depth of a sheet of water spread over the entire catchment. Run-off is sometimes based on precipitation data, which is naturally expected to be a governing factor, but a large number of variable conditions, such as evaporation, climatic and topographical features, storage, etc., have a modifying influence. The rates of run-off also vary on the different portions of a given drainage area; thus in a large basin the rates of run-off may be small if the greater portion of the basin is nearly level, but at headwaters of the streams, where the slopes are steep, the rate of run-off will be greater.

The safe possible yield for water supply cannot be computed until the following data are obtained: (1) catchment area; (2) rainfall—(a) minimum year, (b) series of dry years, (c) average of a long series; (3) ground-water data; (4) available storage capacity of the stream; (5) loss by evaporation and percolation; (6) measurements of actual run-off of the stream.

Stream Flow

Where the catchment area is comparatively level and well covered with timber and grass and the soil deep, the rate of run-off is consequently low and the discharge of streams is nearly constant, being subject to few and not excessive flood rises. This occurs where, as in most cases, the larger portion of water reaches the streams by seepage. Where the catchment basin is precipitous and barren very little water soaks into the soil, and after a heavy storm most of the water runs off in a very short period, resulting in great floods.

In cases where the annual discharge of a stream is not known, approximate data can be obtained by multiplying the depth of run-off by the area of the catchment basin. This gives approximate information regarding the mean annual discharge, but does not indicate the monthly variation, especially during the irrigation period. A discharge curve is important for this purpose, and if such a record is not available, gaugings should be made.

Determination of Discharge

The surface flow of streams may be determined in three ways: (1) By measuring the slope and cross-section and applying a formula of the Chezy and Kutter type—this method is very rough and should be used only in special cases, as in flood times or when no water is flowing; (2) by weirs, using the Francis formula—this method is quite accurate; (3) by using a current meter—from which the results obtained are fairly accurate provided the instrument is kept in repair.

Rating Tables

For stations with permanent beds, it is possible to prepare from the data collected, station-rating tables, each of which gives for its station the discharge corresponding to any stage of the stream, and also when applied to the daily gauge heights, gives the daily discharge. The basis for a station-rating table is a rating curve which shows graphically the discharge corresponding to any stage of the stream and is usually constructed by plotting the results of the various discharge measurements with gauge points as ordinates and discharges as abscissae. These points locate the curve.

By the use of the discharge curve and accurate gauge height readings, a fair idea of the water flowing through daily is arrived at and hence the amount of water available for irrigation purposes is determined.

Most of the information necessary for an engineer in investigating the feasibility of an irrigation scheme can be supplied by the Hydrographic Service of the Department of the Interior, Ottawa. In case the data of the Hydrographic Service does not cover a proposed source of irrigation, the engineer should determine the approximate drainage area above the point of diversion; the nature of the land composing it, that is, whether the slopes are steep or flat, timbered or bare; the kind of soil, whether likely to absorb a large proportion of precipitation. Information should be obtained regarding precipitation, more particularly concerning its division into rain and snow. The peculiarities of flow in the source of supply should be considered—whether the stream has a constant flow, and the nature of the feeders that maintain it. Observations regarding the size and slope of the channel, erosion due to flood water and the nature of the bed and banks, are often of value.

In considering any proposed irrigation scheme, the nature of the land must be carefully considered in relation to its slope, ascertaining the approximate fall in feet per mile, together with other characteristics of the surface. Attention must be given to the composition of the soil, together with the abundance and quality of the vegetation found thereon and the kinds of growth best adapted to it under irrigation.

Reservoirs

The reservoir problem is of great importance in determining the probable success of any irrigation system. A storage supply is obviously necessary when the stream flow is periodic; also where there is a constant low flow, a reservoir is advisable in that it gives control to the methods of irrigation, that is, a larger head can be turned into the ditches, covering the land more quickly and avoiding heavy seepage losses found in small streams. In the West, in the majority of cases, the source of supply is periodic only and reservoir facilities are required. Three systems are applied:—

(1) Dyking system. This is the least expensive and at the same time the least efficient, since the land that it is actually intended to irrigate is completely under water during long periods. It is frequently the only method available, however, without expensive outlay. It is used on comparatively smooth flats, having a fall of not more than 10 or 15 feet to the mile. The dykes are most successfully constructed on contours so that the high water mark on one reaches the bottom of that next higher. A thorough system of drainage ditches is required with this system of irrigation.

(2) Reservoirs within the stream bed.—These are obtained from damming the stream valley and are consequently more expensive than dyking systems. The

dams must be strong enough to resist freshets and of such form as will allow the safe passage of excessive flood water through suitable wasteways.

(3) Storage basins outside the stream.—These make the most satisfactory system wherever they are feasible at a moderate cost. A sufficient elevation must be obtained for the reservoirs to deliver water to the highest point of the irrigable land. This involves many difficulties of construction, owing to cost of dams, intake ditches and proper outlets. Furthermore, the intakes must be of large capacity if they are to utilize flood water to the best advantage as they should be able to fill the reservoir within the usual flood period of each year.

Duty of Water

This term is used to express the amount of work that water does or may be expected to do in irrigating crops. It is an important quantity in the design of an irrigation system, because on the duty of water for a given soil and region often depends the financial success of an irrigation enterprise. The duty of water varies primarily with the crop; it varies also with the temperature of the locality and conditions of the ditches.

The duty of water is expressed usually in either of the following ways: (1) By the number of acres of land that a second-foot of water will irrigate; (2) by the number of acre-feet of water required to irrigate an acre of land. It is important to consider whether the duty of water is computed from the quantity entering at the head of the canal or the quantity applied to the land. Considerable seepage and evaporation occurs between the headworks and the land, so that the difference in meaning is quite evident. It is estimated that in Saskatchewan one second-foot at the head will irrigate 150 acres. This figure applies to the hay crop, and would, of course, be different were the soil required to grow other classes of vegetation.

Rotation Necessary

If irrigation were in progress at the same time at all points of the same canal, sufficient water would not

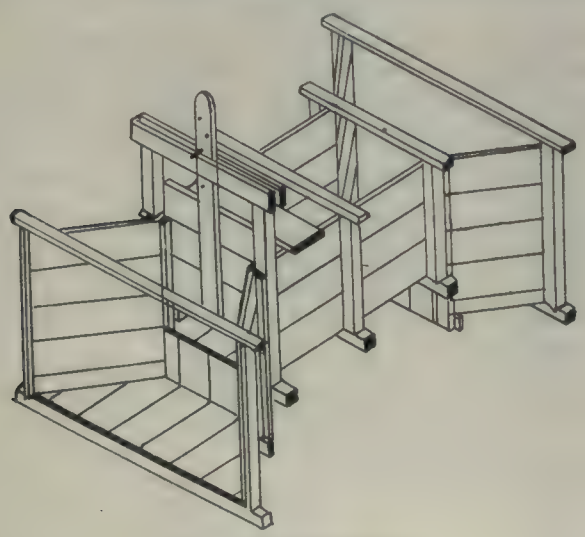


Fig. 1—Headgate of Timber.

reach the lower portions to properly water the bed of the ditches. It is therefore customary to divide the system into sections and permit the irrigation of only certain of these at one time. This is done by establishing a system of rotation, giving each section a definite service period under different heads.

Classes of Irrigation Works

Irrigation works may be divided into two classes—gravity and lift irrigation, the former indicating that the water is conducted to the land by gravity or natural flow. The gravity methods include perennial canals, periodical and intermittent canals, inundation canals and storage works.

Lift irrigation includes those forms in which the water reaches the land by mechanical means. This

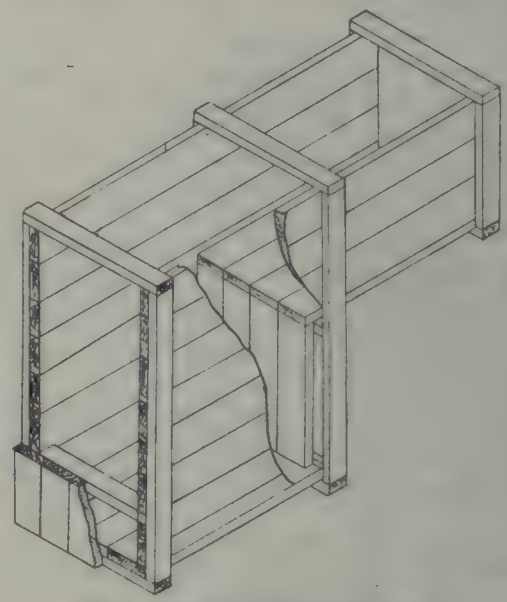


Fig. 2—Sketch of a Drop made of Timber.

method is seldom used on account of the high cost, unless the supply of water is known to be ample and the results sufficient to warrant it.

The conditions required to develop an irrigation canal are these: It shall be carried at a high elevation to provide sufficient fall for the irrigation of land to a considerable distance; its source of supply should be such as would render it a running stream; the slope and velocity must also be such as to reduce the deposit of sediment and the growth of weeds to a minimum; the velocity should be as high as possible to reduce the cross-section for a given discharge.

When stream flow is intermittent or periodic on account of small irregular precipitation, intermittent canals must be used or else storage works built. The former are usually small and take care of only small areas of land. Storage basins are chiefly employed, receiving their supply from intermittent streams which carry sufficient volume of water in time of flood to fill the storage areas. Works are constructed for diverting water from these sources.

Inundation Canals

Inundation canals employ flood water. As a rule they require no extensive head works, but simply a cut in the bank of a stream at a sufficient elevation to allow only flood water to enter. At low water the canal is not employed. This scheme has not proved very satisfactory, for frequently the head has not been sufficient to flood the low-lying lands, especially when the ditch is of some length. If a dam is thrown across the stream the water supply may be more certain, but the cost is often against this proposition.

Perennial Canals

Perennial canals derive their supply from streams or reservoirs. There are two classes, low-lying canals and low service canals, depending on the location of the headwork. The former are generally of moderate size, designed to irrigate lands of limited area. Lying adjacent to the higher hills, their slope is usually flat,

in order that their grades may remain high. The headworks of such canals must necessarily be located high up in the stream.

Parts of an Irrigation System

Any irrigation system may be roughly divided into the following parts:

(1) Source of water supply.
(2) Irrigable lands.
(3) Main canals.
(4) Headworks and regulating works.
(5) Control and drainage works.
(6) Laterals.

The source of water supply is the most important feature of an irrigation scheme. Its relation to the extent of irrigable lands is also important. The head works usually consist of a diversion dam or weir with regulating gates (Fig. 1) to control the amount of water to the canal entrance and wasteway for carrying away the surplus. Along the canal line control works are built for the regulating of the water admitted to the laterals. Falls or drops may be constructed to neutralize any excessive slope of the country. The laterals are the channels which receive the supply from the main canal and supply it in turn to the ploughed furrows.

Alignment of Canals

After the source of supply and its relation to irrigable lands have been considered, the alignment is important. A contour topographical map of the irrigable area should be made with all possible routes for the diversion of water. The more direct the location selected, the shorter the line, the less the cost of construction and the less the losses. Grade contours need not necessarily be followed, as sometimes by the use of drops (Fig. 2) a more economical location can be obtained.

Drainage of low-lying lands must also be considered and care must be taken not to use natural drainage as irrigation channels. Much trouble is experienced by obstructing natural drainage paths.

Grades

A steep slope may bring the canal to the irrigation canals at too low an elevation. Too great a cross-section will cause an increase in the cost of construction. The slope and cross-section must therefore be proportioned to involve the most suitable velocity and the moving of the least material.

The slope depends largely on the soil; it should be steep enough to prevent silt deposits and flat enough to avoid bank erosion. The following velocities are often employed:—for firm gravel, rock or hardpan—a velocity of from 5 to 7 feet per second; for ordinary soil or firm loam—a velocity of from 3 to 3.5 feet per second; for light sandy loam—a velocity of from 2 to 2.5 feet per second. Knowing the velocities and selecting a cross-section, the grade may be ascertained. Convenient tables have been developed for these computations.

Cross Section

Vertical-sided excavations are the most economical but they can be made in only the firmest rock. A trapezoidal form is the best. The inner slopes of the banks may vary from 1:1 to as low as 4:1, depending on the character of the soil. A slope of 1½:1 is sufficient in ordinary firm soil.

The cross section may be so arranged that the water may be carried wholly in excavation, wholly in embankment or partly in either, depending primarily on the alignment of the canal and secondarily on the character of the soil.

The amount of material moved is a minimum when half is in cut and half in fill. This does not necessarily give the best service as leakage losses are liable to occur in embankment and in excavation seepage losses are likely to be excessive if the soil is of sandy character. To avoid leakage in embankment flumes are often used on the fill.

Headworks

These consist principally of:

1. Diversion dam or weir.
2. Sluiceways.
3. Regulators at the head of the canal for its control.
4. Wasteways for the relief of the canal below that point.

Diversion Dam or Weir

To raise the low water level of a stream to a height sufficient to maintain the required supply in the canal, a barrier is built across the stream. The type depends on the local conditions affecting the site selected and the materials available for construction. A sluice-

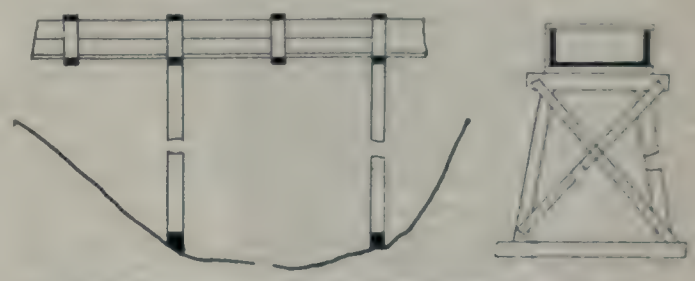


Fig. 3 - Elevation and End View of a Flume Carried on Bents.

way is used to control the excessive floods. Sluiceways are placed in the bottom of the dams to remove any sediment that may be deposited in front of the regulator. There are two types—the open sluice and the under sluice. The former is almost identical with an open weir. It is a solid weir open for only a short portion of its length. Undersluices are employed with high dams and are commonly applied to dams which enclose storage reservoirs. Sluiceways are also used to carry away excess.

Canal Regulating Gates

The gates (Fig. 1) control the water entering the canal from the reservoir. The canal head is placed, as a rule, immediately adjacent to the dam and forms a part of that structure. The gates should easily regulate the amount of water at all stages of the stream.

Wasteways

Wasteways are employed to carry away excess water as in times when the floods are beyond the capacity of the system or when water is not required. Artificial wasteways are usual but at times the location of the dam is such that a natural overflow channel exists which acts as a wasteway when floods reach to nearly the height of the dam.

Flumes

Flumes on bents or bridges are used to cross gulleys or streams. On an earth fill flumes are used to avoid excessive seepage. They may be made of either wood or metal. Fig. 3 shows a flume crossing a gulley.

Lessons from the Jutland Naval Battle

The "Engineer," London, Eng., has devoted considerable space to different engineering features of the European War, from time to time, discussing them in an impartial way, as is the habit of The Engineer, in general. In its last issue there is a fine review of the naval battle of Jutland, following Admiral Jellicoe's report, which is especially interesting as coming from such an authoritative source and one, presumably, in a favorable position to form as accurate a judgment as the facts given out by the Admiralty will admit. We are glad to note the attitude taken by The Engineer—that our enemies have not shown any evidence whatever of the super-man. They sprang no surprises after their many months of hiding. It is about time that the general public should realize—as the soldier in the trench has done all along—that the German, in war, is merely a human being with inhuman instincts. The article follows:—

The Battle of Jutland

After waiting impatiently for it for some weeks the public was given on Friday last Admiral Sir John Jellicoe's report on the Battle of Jutland. We already knew that the British Navy had driven the Germans back to their safe refuges, had sunk many vessels and crippled as many more, and, with sufficiently serious losses on its own account, had retained the mastery of the sea. All this we knew, and it is probable that Sir John Jellicoe's intricate report conveys but little more to the average layman. The broad issues of the battle were pretty well known before, and the details can only be followed by very careful analysis which few people will take the trouble to make. Even Sir John is far from certain how many or what German ships were sunk besides those admitted by the enemy. But the details of the fight, the tactics employed, the resultant losses in tons of ships are small matters which may be left for the future, as green and perennial a problem as Trafalgar itself. What we do know now with absolute certainty is that the German fleet was badly beaten, and that is all we need to know for the present. A remarkable confirmation of this fact is to be found in the report that a number of British vessels—which had sought refuge in Baltic ports and been unable for months to escape the vigilance of the enemies' cruisers—have now left and returned to their own country, a welcome addition to her mercantile fleet.

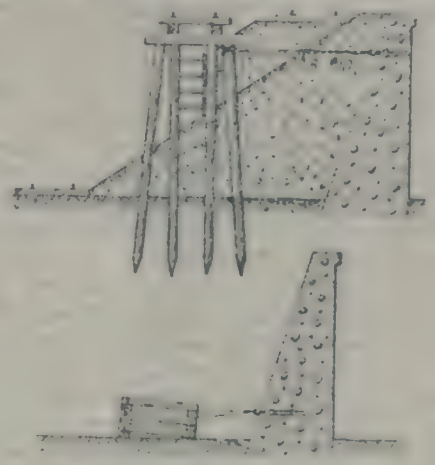
But if the report gives us but little greater knowledge of the Battle of Jutland as a whole, it does give us a little inner knowledge about the handling of our fleet and of the men and material that compose it. Writing of the battle soon after its occurrence, we paid a little tribute to the engineers and expressed the belief that the Admiral would give them their mead of praise, and this he has done in the following words: "Details of the work of the various ships during action have now been given. It must never be forgotten, however, that the prelude to action is the work of the engine-room department, and that during action the officers and men of that department perform their most important duties without the incentive which a knowledge of the course of the action gives to those on deck. The qualities of discipline and endurance are taxed to the utmost under these conditions, and they were, as always, most fully maintained throughout the operations under review. Several ships attained speeds that had never before been reached, thus showing very clearly their high state of steaming efficiency. Failures in material were conspicuous by their absence, and several instances are reported of magnificent work on the part of the engine-room departments of injured ships. The artisan ratings also carried out much valuable work during and after the action; they could not have done better." In this passage the praise engineers will value most is conveyed in the allusion to the high state of the steaming efficiency of the fleets, and the fact that "failures in material were conspicuous by their absence." This means that even under the great stress of an unending vigil, day and night, winter and summer, the machinery of our fighting ships has been kept up to a pitch of excellence which is unsurpassable. What this has involved in the engine-rooms we may imagine; but are not permitted to describe, since the Admiralty has withheld from technical papers permission to visit the fleet, but we cannot doubt that there have been many occasions when the engine-room has been taxed to the utmost to maintain that steaming efficiency for which Sir John Jellicoe praises it. We may also justly take pride in the machinery itself. In earlier actions there have been mishaps of one kind and another of a more or less serious nature. One of these led to a certain important modification being made in many ships, and as there is no appearance of the same trouble having recurred we may presume that the change has proved effective. It is probable also, in the highest degree, that many extremely valuable lessons have been learnt not only in the engine-room, but in connection with the hull and the emplacement of guns. Several very curious things are discussed amongst engineers, but must not be mentioned here. It is to be hoped that when the war is over some of them at least, which must be as familiar to the Germans as to ourselves, will be dealt with publicly. We have never been convinced that the Navy gained more than it lost by the reticence which has been insisted on during the last ten years or so. But apart from these facts, which are still secret, we have one or two statements in the report which throw some light on recent developments. Of these the most remarkable is that concerning the action of the Marlborough. "This ship commenced at 6.17 p.m. by firing seven salvos at a ship of the "Kaiser" class, then engaged a cruiser, and again a battleship, and at 6.54 she was hit by a torpedo and took up a considerable list to starboard, but reopened at 7.3 p.m. at a cruiser, and at 7.12 p.m. fired 14 rapid salvos at a ship of the "Konig" class, hitting her frequently until she turned out of the line. The manner in which this effective fire was kept up in spite of the disadvantages due to the injury caused by the torpedo was most creditable to the ship and a very fine example to the squadron." This, when one remembers the destruction wrought by torpedoes on older vessels, is a remarkable record, and would seem to indicate that in our later battleships protection against underwater attack has been greatly improved. The freedom with which the torpedo was used by both sides is another

notable fact, but it is extremely difficult to tell from the report of the battle if it was more destructive than the gun. Several ships blew up, but apparently rather as the result of fires caused by shot and shell than by underwater attack. We have endeavored to estimate the number of hits scored by torpedoes, but the task is not easy. As far, however, as we can see, ten of our torpedoes found targets in important enemy ships. A hit credited by Sir John to the Moresby was remarkable; the torpedo was fired apparently at a range of about 14,000 yards, say eight miles, and eight minutes later a ship in the line at which it aimed was struck. If this was not remarkable luck it was fabulously clever shooting. It is worth noticing, too, that submarines seem to have taken little effective part in the action. There is no mention of our own, and the Germans have asserted—in contradiction of the Admiralty statement that one of theirs had been sunk—that they had none present. This is certainly not the opinion of Sir John Jellicoe and Sir David Beatty, who speak frequently in their reports of enemy submarines being seen. Machinery mishaps were, as Sir John reports, conspicuous by their absence, and the only instance mentioned is that of the steering gear of the Warspite, which, owing to an accident, jammed and apparently turned the ship full into the enemy's fire. By skilful handling she was brought out of a dangerous position. From this misadventure, which might have had serious consequences, we may rest assured useful lessons will be learned and duly applied. Indeed, we may be confident that the result of the action will be many changes in the fleets of all nations. Modern ships of war have never before been so severely tested, and whilst we have every reason to be proud of our designs and well satisfied with what they did it is impossible not to believe that improvements will be the outcome of the battle test.

Looking at the action as a whole from the technical side, two facts seem to stand out with particular prominence; they are first the great number of torpedoes fired, at long ranges, be it noted, and secondly, the success of the gun. It is recognized that hitting by single shots at long ranges is extremely difficult and attack is now made by the firing of salvos. The arrangement of gun emplacements and the control in our more recent vessels facilitates attacks of this kind —observe, for example, the brilliant work done by the Marlborough—and appears to be fully justified. How far our armouring is effective we have no means of knowing, as not a word is said in the report that throws any light upon it. The fact that our highly armoured ships suffered most is in this case no criterion, as the German navy beat a hasty retreat when our battle fleet appeared. Of the six ships we lost all save destroyers were cruisers, and several of them of a comparatively old type; the Warrior, the Black Prince, and the Defence were between nine and ten years old and carried 9.2 in. guns, the Invincible was completed in 1908 and the Indefatigable in 1911, they carried 12 in. guns; the Queen Mary, the biggest of the six, was about three years old, she had eight 13.5 guns and was "modern" in every respect. Her loss is the most serious. There is no word in the report that gives us any clue as to how she was sunk. On the other hand, it is believed that the Germans lost at least three of their battleships. We cannot, however, from this fact form any safe opinion on the relative merits of German and British designs, as the enemy at the time was in disordered retreat, but we have the satisfaction of knowing that the gun-fire of the British fleet was unquestionably superior to that of the Germans. One other remark remains to be added. Those persons who consistently disbelieve in the ability of their own country, and are confident that Germany is always ahead of her in science and invention, had frightened themselves and others with unfounded rumors of new weapons and new terrors the Imperial Navy had developed since the war began. These were all fabrics of their own brains galvanized by Teutonic suggestion. Nothing of an unexpected kind was used.

Methods Used in Track Elevation

The raising of the tracks on the Chicago, Minneapolis & St. Paul Electric Railway in Chicago involved some intricate problems, due to the narrowness of the right-of-way and the necessity of leaving the train traffic undisturbed. The method employed has been to erect a concrete retaining wall on one side, raise one track on a trestle, fill and then raise the remaining track. The illustration shows the way in which the trestles were erected and the methods of holding the fill away from the low level track. A decided saving over the use of tie cribbing was accomplished by the use of planks placed against the trestle. The trestle itself was tied to the retaining wall by wires connected to hooks set in the wall and passing around the tops of the nearest piles. Planks were set on edge against one of the centre rows of piles and braced against other parts of the trestle, in this way keeping the fill from the low level track. At the stations there was not room enough to avoid tie cribbing. The cribbing used here was not of the ordinary solid type, but was laid box-shape and tied back to hooks on the retaining walls. The sketch illustrates the two forms of bracing.



Bracing used in Track Elevation

Roadway for New Glasgow, N.S.

The town of New Glasgow, N.S., has just awarded the contract for the construction of 5,500 square yards of reinforced concrete roadway to Messrs. Fage & Lusby, of Amherst, N.S. This roadway will be over 3,000 feet in length and 16 feet wide, on a section of the highway connecting the towns of Trenton and New Glasgow, over which there is a very heavy wheeled traffic between the works of the Nova Scotia Steel Company, the Eastern Steel Company, the Maritime Bridge Company, and the various minor industries in the town of New Glasgow. Mr. E. S. Fraser is town engineer.

The City Manager

by R. L. Fitzgerald*

Those of you who have followed the public service business during the past fifteen years can remember the wonderful improvement in the business from the standpoint of service, operation and earning capacity that occurred as the various properties throughout the country passed under the control of the large operating syndicates and the management passed from the hands of the old school public service managers to the hands of the highly trained scientific manager that guides the destinies of the industry to-day.

The condition of operating efficiency that existed in the public service plants of fifteen years ago might be considered the height of perfection when compared with the state of operating efficiency obtained in the average American city to-day. If the new form of government is permitted its full development, according to the ideas of its framers, the results in the form of improved and extended service at greatly reduced rates will outdistance the most shining example of the results of the introduction of progressive and scientific management into the public service industry that is on record to-day.

With the widespread adoption of this new form of city government comes the introduction of a new profession, that of city management, and with it a demand for city managers. As this profession is still in its infancy at this time, it cannot be definitely determined from what field of business the men best adapted for the work will be chosen. However, a careful analysis of the duties of a city manager will show that the duties resemble in a general way the duties of the manager or a public service corporation. The successful city manager must be an able executive, he must be able to deal with the public with the least possible friction, he must have some knowledge of accounting and cost keeping methods, he must have some knowledge of engineering, he must have the ability to develop a keen sense of interest in the general welfare of the community which he manages, and above all he must be absolutely honest. The extent to which all these qualifications are necessary depends upon the size of the city to be managed, upon which depends the ability to hire highly trained experts as heads for the several departments, but executive ability and absolute honesty are essential for cities of any size.

As a knowledge of engineering is probably the most difficult of the necessary qualifications for an untrained man to acquire, and because the majority of our municipalities are not large enough to maintain specialists in each department, the engineering profession will probably be called upon to supply the necessary men to fill the positions of city manager. This conclusion is substantiated by the fact that fourteen of the sixteen city managers that attended the second annual convention in Dayton last November were engineers by profession.

The choosing of the manager is probably the most important problem that confronts the city commission. Upon the ability of the manager depends the success of the entire system, as does the success of any business depend entirely upon the management. Frequent changes of managers are detrimental to the system because they destroy the continuity of fixed policy and create openings for the spoils system. For this reason the selection of the first manager is all-important.

As the profession is still in its infancy and might be considered in what is usually termed the experimental stage, the number of eligible candidates for the position is quite limited. There are numerous advertisements in the current trade journals advertising for positions as city manager, but these advertisements are mostly from men who can hardly be expected to make the system a marked success, because the man who has the ability to make it most successful is probably pretty well located and cannot be induced to change to a position that is more or less experimental and may be somewhat subject to the whims and fancies of the voting populace unless he is going to be benefited by a substantial increase in salary. Until the new system has passed through the experimental stage and the new profession has been permanently established capable men for the position of city manager will demand comparatively large salaries.

When a man is confronted with the problem of deciding between remaining in his present position and accepting an offer of a position as city manager a few of the questions that he gives careful consideration are:

(1) To what extent is the position a permanent one?

(2) How long will it take to educate the voting public to the point where they will keep properly informed on the results being obtained by their city government and lend their active support to the system that will accomplish the object of city government at the smallest expense?

(3) Does the present administration honestly desire to install a city manager that will place the city on an efficient operating basis regardless of how many of the friends of their political constituents will lose their pensions by the change?

(4) Will a conscientious effort be enforce the laws without discrimination and manage the affairs of the city in a businesslike manner be appreciated and justly rewarded?

Anyone attending the city managers' convention in Dayton last November could not help noticing how the very young men predominated in number among the managers in attendance. The fact can probably be accounted for on the theory that older men of more experience and possessing the desired qualifications could not be obtained for salaries that the respective cities thought they could afford to pay. The result was that the commissions selecting the managers have turned to the younger men whose short records indicate possibilities. The young man whose entire life is before him, and whose future depends entirely upon the degree of success obtained, certainly has every incentive possible to exert his best efforts to make a success of the system. After accepting the position and taking office the manager will find himself face to face with the problem of reorganizing, which in most cases will mean a complete house cleaning from cellar to garret, because it is a hard matter to teach an old dog new tricks. After reorganization the installation of system begins and it will usually be found necessary to install a complete new and adequate accounting system and a new system of records. After the system is installed and running smoothly the real work begins. The operating methods of the various departments must be studied and means devised to stop the waste and leaks. After these problems are worked out and the operation appears to

* Before the Western Society of Engineers.

be on the best basis obtainable the manager feels that he is beginning to get things into such a condition that he can spend a little time to partake of some of the few amusements that life affords. About that time he realizes that the city is growing rapidly and the public demanding more and more in the way of service from the municipal government. He finds that he is confronted with a few such problems as:

Garbage and waste disposal plants, sewage disposal plants, water filtration plants, booster mains for the water distribution system, adequate water supply and storage, new fire stations, railroad grade separation, new municipal building, elimination of dangerous street intersections, ornamental lighting installation, parks and playgrounds for the children, installation of police and fire alarm systems, and numerous other problems that are forever coming up in a modern and growing city.

The profession holds forth wonderful opportunities for the man with unlimited dynamic energy, untiring love for work, the moral strength to follow his own convictions, and the necessary nerve to pioneer in the unexplored field.

Rideau River Irrigation Scheme

Mr. Noulan Cauchon, consulting hydraulic engineer, Ottawa, has submitted plans to the Dominion Government regarding the possible diversion of the waters of the Rideau River watershed for irrigating an area lying east and south of the city of Ottawa. The engineer's idea is that this would enable intensive cultivation to be carried on, so that this area could be subdivided into small holdings for returned soldiers and other settlers, "enabling the civilized, social and material amenities that develop from denser population and community life." The Government is asked to set apart the water rights of the Rideau River watershed and part of the Nation River watershed for this purpose, and that administrative authority be vested in a Co-partnership Settlement Trust. The engineer suggests that a survey be immediately made of this area, to determine the most promising localities for the operation of the scheme. The map reproduced herewith indicates the area which would be included in the operations.

The area cross-hatched and marked "A" represents over 1,500 square miles of country which drains its waters into the Rideau River, discharging through the canal and over the dam at Hog's Back. It is proposed that the waters from this area should be discharged by irrigation canals over the territory to the east, cross-hatched horizontally and marked "C," greater in area than the collecting watershed "A." The area marked "C" is practically all on a lower level than the discharge of the Rideau River at Hog's Back, and on this account, and with the further advantage of its almost flat character, it would be easy to distribute the water over it and irrigate the land.

Just east of the city of Ottawa an area marked "R" scarcely discernible on this map, represents a reservoir site about 35 square miles in extent, which would be utilized to collect the spring run-off from the Rideau River. This artificial reservoir or lake would be from 20 to 25 feet deep, and the waters would subsequently, during the dry spell, be released for irrigation purposes, in addition to the normal storage which could be accomplished on the upper stretches of the Rideau River.

The area "C," which it is proposed to irrigate, receives sufficient rain-fall during the year, but it is so distributed that a surplus falls in spring and entails a shortage of moisture in the hot months. Irrigation on this territory would, it is claimed, usually enable three crops a year of alfalfa and green feed to be produced from the land. The main object of the irrigation proposal is to so enable intensive cultivation that denser population may be maintained on the land, particularly with a view to creating co-partnership settlements for returned soldiers and others on the basis of small holdings and intensive cultivation.

Proposed Irrigation Scheme—Rideau River District.

Vancouver Engineer Killed in Action

Members of Vancouver Branch Canadian Society of Civil Engineers, as well as a large circle of friends among the business men of the city, learned with sorrow of the death, on May 30, of Lieut. H. J. A. Haffner while bravely fighting for his king and country in the trenches in France. A letter from Lieut.-Col. Anderson, officer commanding, conveyed the sad news to his father and other relatives at Winnipeg. Lieut. Haffner was for a long time employed as an engineer for the C.P.R., but for the two years previous to his enlistment was in business for himself in this city as consulting engineer. He was interested in irrigation problems of the province, and was at one time engaged by the Government on this subject. He was a graduate of McGill University (1904) in applied science.

The town of Renfrew, Ont., are faced with the necessity of purchasing another pumping unit in connection with the local waterworks system. Also, owing to scarcity of labor and prospect of considerable waterworks and sewer extensions being repaired in the next year or two, the economy and desirability of purchasing a trench-digging machine is being considered.

The application of mechanical equipment to multiply the efficiency of manual labor is more insistent than ever, and is indispensable to the successful handling of the low priced commodities that run up into big tonnages. Steam shovels, travelling cranes, grab buckets, and improved crushing and pulverizing devices, as well as power equipment, have got to be selected and provided with a view to the utmost efficiency, and promptly.

Stock Yard Wastes Can Be Treated By Activated Sludge Process

THE activated-sludge process of sewage treatment will satisfactorily purify the industrial wastes from the Packingtown factories of Armour & Co. The space required will be small and, if the sludge can be dewatered cheaply, the cost will be comparatively low. These, in short, are the conclusions arrived at by the officials of Armour & Co. after an extended investigation by their sanitary engineers, M. D. Harding, assistant superintendent; G. L. Noble, engineer, and Paul Ridnick, chief chemist. From Mr. Harding the following information regarding the work has been obtained by Engineering Record:

Packinghouse Sewage Complex.

This sewage is very concentrated and varies widely in its composition, as may be judged from the various manufacturing departments where it originates—beef slaughtering, sheep slaughtering, rendering, cold storage, stick plant, fertilizer works, degreasing plant, wool house, chemical laboratory, lard refinery, oleo plant, butterine factory, soda fountain supplies factory, hog killing, pork curing, canned meats, power plant, and the domestic sewage from 10,000 employees. According to the report on industrial wastes from the stock yards and Packingtown, made to the Board of Trustees of the Sanitary District of Chicago in October, 1914, the minimum analysis showed 58 parts per million of suspended solids and the maximum 2,760.

Taking an average of all analyses made by the sanitary district for each of the three Armour sewers and computing from records held by the mechanical department regarding the flow through each, the results show the average suspended parts per million for the day-and-night flow to be 700.

Analyses made by Armour & Co. in recent investigations, however, show a slight reduction from this figure. This sewage, which originates from so many different sources and which contains so much solid material, is necessarily a difficult sewage to treat.

Preliminary Experiments.

Armour & Co. were the first packinghouse firm to experiment with concentrated industrial wastes, and there was some speculation as to whether the effect would be the same as that produced in more dilute domestic sewage. To determine this, sewage from the beef-slaughtering house was aerated in a tank 5 feet long, 1 foot wide, and 12 feet deep, with an open-air jet. In about twelve days the sludge took on a flaky appearance, and settled fairly rapidly, although the clearer portion was still a yellowish color. The red color of the sewage was also changed to a brown. The vat was allowed to settle, the clear portion was drawn, and fresh sewage was added every 12 hours. In this way a clear, stable effluent was almost always obtained.

Occasionally it was difficult to get the desired result. Then it was decided to aerate a vat until a chemical analysis showed that the reduction of the complex nitrogen bodies was complete. Approximately 15 per cent. of the volume of the tank was filled with previously aerated sludge, containing about 99 per cent. moisture, and fresh sewage from the beef slaughtering was added to make up the remainder. The whole was then aerated, with the following results:

Aeration of Beef-Slaughtering Wastes.

	Nitrogen as				
Time	Albuminoid Ammonia	Free Ammonia	Nitrites	Nitrates	Putrescibility
Fresh	153.1	27.9	..	..	Positive
2 days	129.0	34.0	0.5	..	Negative
4 days	90.8	44.0	1.5	..	Negative
6 days	55.9	69.8	6.4	..	Negative
9 days	41.0	45.4	35.0	..	Negative
11 days	9.3	26.4	44.0	0.7	Negative
16 days	6.5	0.8	130.0	2.7	Negative
18 days	2.8	..	0.1	9.8	Negative
19 days	0.8	..	0.4	13.5	Negative
20 days	0.8	0.6	0.3	16.0	Negative
21 days	1.2	0.4	0.5	14.0	Negative

The foregoing analyses were all made according to the standard methods of the American Public Health Association. The first result was obtained by analyzing the entire sample. The other analyses were made on the clear portion, after the sludge had settled out.

Repetition Brings Quicker Results.

Three facts stand out clearly in the table, according to Mr. Harding. First, oxidation was complete in 18 days; second, there was a loss of nitrogen in the effluent; and, third, the methylene-blue test or the putrescibility, recommended by the American Public Health Association, gave a negative result after only two days' aeration, and long before the effluent was clear.

As soon as the composition became constant the aerated sewage was allowed to settle for 45 minutes, the clear portion was drawn off, fresh sewage added, and the mixture was again aerated until the process was complete. After repeating this a few times the period required to get the desired result was wonderfully shortened.

On adding fresh beef-slaughtering sewage to an equal amount of sludge containing about 99 per cent. water a non-putrescible effluent was obtained after two hours' aeration, although the reduction of suspended solids was not as great as would have been obtained with a longer period of aeration.

A Small Continuous-Flow Plant.

In the foregoing experiment the contained sludge would flake quickly and settle rapidly. These two facts—a quick settling sludge and a stable effluent—were enough in themselves to indicate great possibilities and to justify further research and experimentation. In other words, the bacteriological and chemical action involved was proved to be sound and unfailing, and the next step was to develop a continuous-flow plant, so that the raw sewage, properly screened, would flow in at one point and a clear, stable effluent be continuously discharged at the other, with suitable arrangements for disposing of the excess sludge accumulated.

The first continuous system used by Armour & Co. for experimental purposes consisted of a box 4 x 3 feet by 5 feet, built with horizontal, corrugated baffles in the aerating chamber and having the settling chamber

in the same compartment, separated by a vertical baffle and built with a steep, sloping bottom so that the sludge would gravitate back to the bottom of the aerating tank. The idea was to give the sewage and air a longer flow by the use of corrugated baffles and at the same time trap some of the air in the corrugations, the supposition being that greater oxygen absorption would result. The air also gave a greater head to the water in the aerating side, causing it to flow into the settling chamber where the sludge was to settle and automatically return to the aerating tank and the clear portion overflow the edge. The results gained with this tank were not very satisfactory, because it was so small that the flow of influent often clogged the small pipes.

The settling chamber was satisfactory from the standpoint of being undisturbed by the aeration. The sludge returned readily to the aerating chamber and a clear effluent was obtained. No data could be obtained as to air economy, but experiments on this point are now being conducted on a larger scale.

A 30,000-Gallon Tank.

The necessity of a larger system was at once apparent, so the next step was to build a tank with a capacity of 30,000 gallons per day of 24 hours. It is this system, with additions made from time to time, that is in operation at present, and from which data are being collected that will enable the intelligent design of a plant large enough to purify the 5,000,000 gallons of sewage passing from the company's factories daily.

The data following are largely those obtained from operating the previously described system up to the present time. The plant consists primarily of five units: (1) Air pressure producing unit; (2) aerating tank; (3) settling chamber; (4) sludge storage; (5) sludge dewatering apparatus.

The air-producing unit at present consists of the air-compressing apparatus already in use in the powerhouse. Whether a blower or a small compressor will be used eventually depends on the depth the aerating tank is built. If the aerating tank is built rather deep say, 20 or 25 feet, which from data at present in hand seems to be a desirable depth—then a compressor will be necessary. A blower would probably make the air cost more, considering the pressure necessary, and the load would be too great for a blower. The deeper tank will give a chance for greater absorption of oxygen from the air, which will help to offset the extra cost as the result of the extra pressure required. Of course, the depth of the tank will be determined by the space available, the nature of the footing, etc.

How Should Air Be Distributed?

The tank in which the sewage is aerated is 10 x 20 feet by 10 feet, and is divided by a central partition lengthwise of the tank, with an underflow at one end. The sewage thus enters at one end of the tank, flows the full length, returns on the other side of the partition, and is discharged at the same end at which it enters. This is probably the style of tank which will be considered standard for this purpose, as it provides for few changes in the sewer lines.

Manufactured porous plates were first used for distributing the air, being placed in the trough of a sawtooth shaped false bottom, but they were of uneven porosity, and gave a poor distribution. They were abandoned very soon, and 1-inch galvanized iron pipe, perforated with 1/25-inch holes, 2 inches apart and staggered, were used instead. These pipes, Mr. Harding reports, give a very good distribution, and have the advantage that they can be taken up and cleaned without shutting down the system. It is probable that a better method of distributing the air will be developed.

The sawtooth bottom in the aerating tank has also been abandoned as unnecessary. The specific gravity of the sludge is so nearly the same as that of water that the air keeps it thoroughly mixed with the sewage without the irregular bottom designed to bring any settling sludge back to the point of air discharge. This would probably not be true if the sewage were not well screened or passed through an effective grit chamber previously.

Underflow and overflow baffles are placed in the aerating tank about 6 feet apart and are designed so that the sewage must take a zigzag course in addition to flowing up and down, thereby insuring a thorough mixing and preventing short-circuiting.

The settling chamber is built with a conical bottom so that the sludge will be concentrated at one point and easily siphoned off to the sludge storage. The settling period is about 40 minutes.

The sludge storage may be any shape tank where the sludge can be stored and aerated.

Dewatering Machinery.

At present the dewatering machinery consists of small experimental machines, such as filter presses, centrifuges, and driers. The company has not definitely decided what method of dewatering will be advisable.

The plant is now operating on the continuous flow plan. It requires about 10 to 12 hours' aeration in the presence of 25 per cent. of activated sludge to complete the action and make the continuous flow permanent. Then the sludge is further aerated for about three hours before being returned to the sewage chamber.

The amount of air used is three cubic feet per gallon, or at the rate of 0.3 cubic foot to a gallon per hour. The air is measured by means of an orifice and differential monometer, and the water flow is gauged by a triangular weir.

The sludge resulting from this process has the following composition, based on a 10 per cent. moisture basis:

	Per cent.
Ammonia	5.57
Fat	5.54
Total phosphoric acid	2.05
Bone phosphate of lime	4.50
Water soluble potash	0.43

The value of the sludge as a fertilizer, therefore, depends upon its ammonia contents.

Much work has been done toward finding a practical method of dewatering the sludge. This material, not unlike activated sludge from domestic sewages, is light and flaky—having a specific gravity of about 1.02. The sludge which is siphoned from the settling chamber will average 99.5 per cent. of water.

The first step in dewatering the sludge is further settling. The time of settling is naturally limited by two things—capacity and the fact that the sludge will become septic upon standing too long without air.

It has been found that the sludge can be reduced from 99½ to 99 per cent. moisture with from four to six hours' settling, provided it is in the proper condition. This reduces the volume which must be handled 50 per cent. In other words, the sludge becomes so much more concentrated that there is just half as much moisture to handle. Experiments have shown that settling under hydrostatic pressure takes place with more rapidity, but seems to have but little effect in the

reduction of moisture. What other steps will be employed remains yet to be determined. Centrifuges appear to be a possibility in reducing the greater bulk of this moisture. By this means the moisture may be reduced to 92 per cent. or 90 per cent. The solid bowl pipe has been found preferable.

A drier preceded, possibly, by the use of a Worthington type filter press may be the other two steps in reducing this sludge to a 10-per cent. moisture basis. These remarks are of necessity only tentative, as they are based on the experimental work accomplished to date. It is possible a better method than any here suggested may later be found.

Cost of Treatment.

At present it is very difficult to estimate what the cost of operation will be, as it is not known what the expense will be to dewater the sludge. Following is an estimate by Mr. Harding of the cost per 1,000,000 gallons, as judged from the data available to date:

Air, 3,000,000 cubic feet at $0.003 per M.	$ 9 00
Drying and preparing sludge for fertilizer (two tons at $6)	12 00
Labor (considering capacity of 5,000,000 gal.)	2 00
Total	$23 00
Byproduct, 2 tons fertilizer (5 units ammonia at $2)	20 00
Probable cost per 1,000,000 gal., exclusive of interest, depreciation, and repairs	$3 00

The cost of air will vary, depending on the price of electricity. Depreciation, repair, and interest will probably remain fairly stationary. It is hoped that the sludge dewatering cost may be materially reduced.

A rectangular plant seems to be the most feasible plan of construction. Aerating chambers, settling chambers, and sludge storage tanks may all be included in the plan to advantage, as has been done in the experimental plants of several cities. The amount of space required will be about one-tenth to one-eighth of an acre per 1,000,000 gallons, depending on the depth of the system.

The problems yet to be solved present themselves in about the following order of importance: (1) Dewatering of the sludge economically; (2) best method of distributing the air; (3) the relative length of time of aeration of sewage and sludge; (4) unfavorable influence of rapidly changing temperatures of the sewage.

Possibilities of Concrete as a Medium of Aesthetic Expression

By Irving K. Pond*

AT the forty-first convention of the American Institute of Architects, held in November, 1907, I, as chairman of the then existing committee on Applied Arts and Sciences, reported on the possibility of concrete in the field of architectural expression. Much of that matter, which I formulated then with the assistance and approval of the other members of the committee, is applicable altogether to the subject today. The introductory sentence was as follows: "Although the exact relationship existing between concrete and steel reinforcement under a given condition is yet to be determined accurately, and the structural use of reinforced concrete reduced to an exact science, and although the manipulation of concrete and its application to structural uses has not become an art, yet the fact that in its use and treatment there are immense scientific and aesthetic possibilities, brings the subject of reinforcement well within the field of study of this Committee, especially at this time when the general topics of steel structure and concrete reinforcement are before the Institute for discussion." The science during the years which have elapsed since that was written has possibly become a bit more exact, engineers have been at work—many formulas have been developed, many tables have been compiled and much has been gained in the way of practical experience. This has been of benefit in developing the art of manipulation, for Art consists in "doing"; but the art of design seems not to have kept pace. It was to stimulate that art and to awaken in the architect a realizing sense of his opportunities and responsibilities that I then entered into the discussion and now continue it. It is essential throughout such discussion to keep clearly in mind the true and abiding status of architecture and the architect. The architect is not a mechanical fabricator of mathematical diagrams. His highest concern is with the ideal, and his first sketch should present an idea, an idea which is conceived in beauty. The past has demonstrated that architecture as the expression of the ideal can materialize in but one or the other of two great manners: that of the articulated structure, unit added to unit, and that of the plastic mass. The most noble development in the first manner is in the architecture of masonry—brick or stone—and this development has reached its logical limit; in no way except, may be, in mere size, its least noble attribute, is it to be excelled. Under the vital art of this first manner lay an intuitive science; under the too transient beauty of the work of the second great manner lay nothing of science at all, and so this architecture has well-nigh vanished except as some adherence to the principles of the first manner has interposed to save. And now comes the ghost of what might have been and calls for an incarnation, feeling, if a ghost can feel, that in reinforced concrete, science is preparing a body which can be vivified with the spirit of art. If this feeling is substantiated, to the architect is opened up a new range of possibilities. The architect becomes in a sense a sculptor, a molder of monumental mass, not the fantastic figure, who, at first, with sharply insistent blows, and then with infinite persuasive tappings, releases the form imprisoned in the block, but a creative constructor who builds up his ideal and shapes it by the irresistible, though tender, molding of mass and form. In this the architect assumes no new function, but develops that feeling which by nature and of necessity inheres in the architectural mind. The vital difference between the sculptor and the architect is that the former is bound by no necessity for expression in structural terms; mass and form being enough for

*Architect, Chicago, before the American Concrete Institute.

him; while the architect, if he really is to be an architect, must have structural laws ever in mind, and must make his work an interpretation of these laws and a symbol of their aesthetic value in the expression of the higher ideals of his race and time. The architect as well as the sculptor revels in this feeling of mass taking form under his skillful manipulation; and the feeling for plasticity and for mass influx is potent in the true architect, even though he be designing in that most refractory medium, a masonry-clad steel skeleton. In most of his work the architect has to content himself with an intellectual substitute for real feeling, and his conscious delight is rather intellectual than emotional as the idea takes form in the sketch and in preliminary plan and elevation. His fingers may itch, they do itch, to feel the flow of the mass, but the feeling remains abstract and intellectual. Therefore certain architects, if not indeed the architectural body general, are viewing with keen interest, when not actively aiding, the development of the possibilities of this fairly new and altogether plastic medium, reinforced concrete; a medium which really does flow and is molded, and through which the form appears in gracefully unfolding stages, till the final mass stands revealed, a veritable unit. One cannot in thought connect with this materialization the shock of unloading beams, the rattling musketry of riveting, the petty and fussy application of fireproofing and surface coating. In fancy, as almost in fact, the architect sees the flowing mass take form under his own hands.

Plastic Architecture in its Infancy

Though the use of concrete goes back into antiquity, plastic architecture would seem to be in the veriest infancy, and would seem also to be asking the genius of this age to give it perfect expression and make it worthy to stand with the architecture of the past and the yet-to-come. Though the past be examined for precedent, little will be found. Rome used concrete in bulk— but undeniable evidence of a scientific use of the material is wanting. Rome applied superficially the arts of other times and countries, but of itself left to posterity only monuments expressive of a highly temperamental force, breathing little or nothing of spirituality. Persia covered with stucco or veneered with beautiful tiles her masses of crude masonry. The Arabians and the Moors expressed their emotionalism in a plastic architecture decorated with a skim coat of ornamental plaster or an incrustation of tile, intricate in pattern and beautiful in color. The concrete of the mass was but mud, and the science of building was unknown. In such material beautiful day dreams were realized only to crumble when the spell was past. The Spanish missions were built with rare feeling for mass and light and shade; but feeling swayed and science did not guide. With the science of to-day to guide and the art of experience of the past to illumine, into what logical, noble and beautiful forms should not concrete shape itself, to the end of an enduring, spiritualized architecture!

The possibilities, even the aesthetic possibilities, within the range of reinforced concrete construction can hardly be over-estimated. Little beyond the introductory chapter has been written in the history of reinforced concrete, and every advance in the science of its manufacture and use will signal an advance along the line of artistic application.

Except in well-defined types, designed to serve certain well-defined uses, it is impracticable so to carry masonry construction beyond and behind the facade as to result in a homogeneous structure wanting which architecture becomes but a hollow sound. The architecture of a reinforced plastic material may, and logically will, express itself throughout the entire structure of the remotest core. The unity, the truth, the harmony of the whole may in every part be manifested. Therefore, again, the possibilities inherent in concrete present themselves alluringly to the architect to whom the art means as much as does the science of building.

Time Required

The architectural brain is not so congested by the weight of pregnant thought that at a blow a Minerva shall issue forth full fledged and full armed. It will take time and struggle, and developed artistic preceptions in this, as in former cases, to reveal the possibilities of beautiful and of monumental design.

It may well be conceived that a molded architecture, so to speak, an architecture of flowing and harmoniously interrelated masses, may not appeal immediately to the architect who has been taught that his art consists in naively piling up child's building-blocks on a large scale. Whatever may be urged against the deadly dulling practice of following the line of least resistance in architecture, certain it is that a material in which it is easier, as well as more logical, to fashion new and appropriate forms than to follow cut and dried conventions, can not be regarded as other than a vivifying factor in a possible architectural development, and its advent hailed with delight. When architects relieve themselves of the notion that monumental architecture, for example, consists solely in a row of classical columns superimposed upon a basement, it will be a wholesome day for the art they profess to practice. Probably ignorance, inability and self-distrust in the architectural ranks will remove to some more or less remote future the development of a monumental architecture expressing itself in new forms fashioned in new materials. Yet it is possible in this, as in other ages, that commercialism, itself so devoid of aesthetic tendencies, will pave the way to the realization of an aesthetic ideal. A material which holds in itself the qualifications for commercial use will in that very use reveal its aesthetic possibilities. No material which puts into the hand of the architect power to produce permanent mass and form, and add the enrichment of light and shade, color and texture, will long be ignored when science has made its use commercially possible. It would, then, seemingly remain only for science to demonstrate the practical value of reinforced concrete, in respect to its physical properties, and art must unfold whatever it holds of beauty.

Unlimited Possibilities in Concrete

The steel skeleton developed from commercial necessity, and to clothe and protect that skeleton, the architect, naturally, used whatever means lay at his command; stone, brick, terra cotta and metal were called into requisition. To clothe the skeleton in one or another or all of these materials became a fixed habit with the architect. So that when concrete came into use, not only was it ignored as a possible clothing for steel, but when the skeleton of reinforced concrete was set up it was itself clothed after the existing fashion for steel. Such is the fatal force of habit! Granting to concrete the qualities ascribed to it, that it is fireproof, that it may be rendered moisture proof, that once in place it is not affected by atmospheric and climatic conditions, that it can be permanently

colored, can be molded and chiseled, that it can be formed in place and need not be applied piecemeal—what better material could be sought for clothing the steel skeleton?—and why the need of any cloak at all to such material when it has been treated with any manner of decency or respect by the designer? So aesthetically there would seem to be unlimited possibilities in reinforced concrete.

It is not inconceivable that ornamental terra cotta and tile, beautiful in color and texture, and also sculptured stone will be called upon to embellish and distinguish, though not in any manner to clothe or conceal, the concrete structure. The presence of these materials may be needed as a saving grace in these early days of design in concrete, to save the designers from a too brutal conception of the forms they deem the material must necessarily take. This is an unfortunate, though marked tendency now, in what should be a refined and restrained domestic architecture, to shape concrete, and its lath and plaster imitations, into the crude, though characteristic, forms of the old mission work. It is needless to say that these forms have no meaning outside of their original environment and would not have existed there but for the exigencies of the case—the crude nature of the materials procurable and the absence of all skilled labor.

A Bright Future

But to-day, with art and science co-operating, it would seem as though architecture were on the verge of an awakening. Commercial architecture with us is beginning to feel the thrill. Abroad monumental architecture as well is showing signs of a renewed joy in life, and structural concrete, both of itself and embellished with richer materials, furnishes the new and seemingly adequate medium of architectural expression.

Much of this was written, as I said in opening, some years ago. Looking back over these years it does not seem that there has been an advance in the aesthetic field as opportunity seems to have offered, or as might have been expected. But we cannot lay this backwardness altogether to the manipulator of concrete nor to the architect. Economics may be a factor, but it could not be a controlling one in a community which had the desire and will to advance in the art of self-expression which the art of architecture pre-eminently is. I know the time is not ripe for a finished and full expression for the community or the national life is not unified and complete; but there are qualities under the surface—refined and human qualities—which might at least find an echo in our concrete structures. Perhaps the echo is being heard, faintly at least. I sometimes think so, but with you all I desire the day to hasten, not only when architecture in concrete or otherwise shall express us, but when we shall have better selves which will demand and receive an interpretation in architecture.

Griffiths Brothers & Co., of London, England, manufacturers of "anti-sulphuric" enamel, "ohmaline," and other insulating preparations well known in Canada, have received an order from the British Government for five thousand gallons of new material which is used to prevent asphyxiating gases penetrating the stitches of the protective masks worn by British and Canadian troops. This new preparation was subjected to the severest tests before being finally adopted. The Canadian agents are Spielmann Agencies Regd., Montreal.

Stationary Engineers' Annual Convention

The Canadian Association of Stationary Engineers held the twenty-seventh annual convention at Montreal on July 25-28. The programme was arranged having in mind the transacting of a certain amount of business and giving visitors an opportunity to see places of interest in the city and district. On the opening day there were speeches by Mr. R. Dyson, of Guelph, the president, and Mr. W. C. McGhie, chairman of the Board of Examiners of Ontario. On that and the following days the Grand Lodge of the Association held its sessions, when questions affecting the policy of the association were considered. Toronto will be the next meeting place. One of the most interesting sections of the convention was the exhibition in the Technical School, this portion of the programme being arranged by the executive officers of the Exhibitors' Association of the Canadian Association of Stationary Engineers. The following were the principal exhibitors:

Canadian Consolidated Rubber Company, Montreal, showed various specimens of their goods, including Canadian spiral packings, water and steam hose, etc.

James Morrison Brass Manufacturing Company, Ltd., Toronto.—This was an attractive exhibit of valves, locomotive injectors, steam regulating and safety valves, etc.

T. McAvity & Sons, Ltd., St. John, N.B., had a collection of literature detailing their various lines, including ornamental fluted cast iron lighting posts.

Dart Union Company, Ltd., Toronto.—Various styles of Dart union pipe couplings were on view.

Canadian Allis-Chalmers, Ltd., Toronto.—Besides a display of considerable literature a Squire improved steam trap was exhibited.

R. E. Cleaton Company, Montreal.—This firm showed a babbit adjustable sprocket rim, which would, it was stated, fit the wheel of any valve.

Canadian H. W. Johns-Manville Company, Ltd., had on show a large variety of their specialties, packings and friction tapes, etc.

Lytle, Smith & Co., Montreal.—Asbestos fibre, flexible metal hose, and belt dressings.

Economy Fuse and Manufacturing Company, Montreal.—Various types of fuses, including a display of the component parts of fuses.

Darling Brothers, Ltd., Montreal.—A large number of goods were on view. These included the Dexter valve reseeding machine, water filter used on boiler feeds, Clark flexible coupling, centrifugal and rotary pumps, and an illustration of the Webster vacuum system of heating.

Sadler & Haworth, Montreal.—At this booth the firm gave a practical demonstration of the qualities of "Amphibia" waterproof belting. A tanned skin, showing the part of the leather used in belt-making, was also shown, together with specimens of mill supplies.

Lyman Tube and Supply Company, Montreal.—The company had on view samples of goods for which they are agents. These comprised cyclone chain hoist, Shelby steel tubing, Garton Daniels lightning arresters, Imperial elevator guide lubricator, Fitz metallic packing, Hoffman ball bearings, Wright wrenches, Matchless trolleys, rawhide pinions, Downbrook graphite bushings, and Lee carbon brushes.

Jenkins Brothers, Ltd., Montreal.—Numerous valves of various types.

H. L. Peiler Company, Montreal.—Here were shown pop and relief valves, recording instruments, gates, boiler furnace blocks, oil pumps, and the Peiler system for burning anthracite and low-grade fuels.

Dominion Belting Company, Hamilton.—Specimens of

Maple Leaf brand of stitched cotton duck belting and belt dressing.

The Goldie & McCulloch Company, Ltd., Galt.—Many photos showing installations by this well-known engineering firm, besides small parts of machinery.

Dunlop Tire and Rubber Goods Company.—A long line of rubber hose, armoured hose, and also of packing. A feature was made of Gibraltar red special belting.

Gutta Percha and Rubber, Ltd., Toronto.—Packing, fire hose, belting, rubber tiles, sheet packing, etc.

Canadian Fairbanks-Morse, Ltd., Montreal.—An extensive exhibit of engines, pumps, water and steam valves, Pratt and Cady valves, traps, packing, tubing, etc.

Canadian Asbestos Company, Montreal.—In addition to raw asbestos, this company exhibited a long line of asbestos products for insulating and building purposes; also goods for which they are agents.

Armstrong Cork and Insulation Company, Montreal.—The company showed models of furnaces in which Nonpareil insulating bricks were used; also specimens of cork covering, paving brick, high pressure covering, etc.

Garlock Packing Company, Hamilton, Ont.—All kinds of steam, hydrant, and other packings.

Morrison & Dagnall, Montreal.—Many types of pipe and boiler coverings.

Richard James, Montreal.—Several specialties, including pyrotectite.

Mainly Constructional

East and West—From Coast to Coast

The Dominion Steel Products Company, Ltd., Bradford, Ont., have been granted a charter.

The International Nickel Company of Canada, Ltd., Toronto, Ont., have secured a charter.

The Western Stone Company, Ltd., St. Boniface, Man., have been succeeded by the Tyndall Quarry Company, Ltd.

The Winnipeg Stone Company, Ltd., Winnipeg, Man., has been succeeded by the Tyndall Quarry Company, Ltd.

During the month of July 310 building permits were issued in the city of Toronto, valued at $467,431.

In May, 1916, the United States exported to Canada 7,627 tons of steel, valued at $411,729, as compared with 1,237 tons last year, valued at $28,453.

Ravary & Leduc, Limitee, have been incorporated, with a capital of $10,000, head office at Montreal, and will deal in hardware, ironware, paints, etc.

The municipality of Assiniboia has purchased a Barford & Perkin's road roller. The sale was made by their local representative, Mr. E. O. Herbert, 81 Walnut Street, Winnipeg.

Building operations in Campbellton, N.B., are unusually active. Builders and carpenters are very busy, and a good season is assured. The building permits for June numbered 11; value, $18,000.

The contract for the construction of the new customs house and examining warehouse at Toronto has been awarded to the Fuller Construction Company. The cost of the buildings will be about $1,500,000.

Building permits numbering 14 were issued at Galt, Ont., during the month of July, amounting to $38,555. Up to July 31 the permits issued total $138,955, an increase over the same period of last year of $57,700

The contract for the foundations and all reinforced concrete work on the St. Gregoire de Thaumaturge School has been let to the Security Engineering and Contracting Company, 263 St. James Street, Montreal.

The Council of Surrey, B.C., at a recent meeting passed a resolution dispensing with the services of their municipal engineer, Mr. J. O'Hara, after August 5, considering that his retention caused too great expense to the municipality.

Fourteen building permits were issued at Galt, Ont., during the month of July, value $38,555, while for July, 1915, the permits totalled $18,325. Up to July 31, 1916, the permits issued amounted to $138,955, as compared with $81,255 for the same period last year.

Official confirmation has been received of the awarding of the contract for the cribwork and back-filling of the new pier 16, on the west side at St. John, N.B., to the Maritime Dredging Company. Work is now being pushed with a view to having the pier ready for the coming winter's business.

It i reported that all the mills except the rail mills, of the Dominion Steel Corporation are working up to full capacity in spite of the fact that there is much difficulty in securing labor, and that the earnings of the steel department are running the highest since the commencement of the war.

There were 101 building permits issued at London, Ont., during the month of July, this year, representing a value of $214,020, as compared with 100 in July, 1915, valued at $266,185. The total for the first seven months of the year is 634, value $584,730, while for the same period last year there were 824, value $873,780.

While some delays have been experienced on the work on the Bloor Street viaduct, Toronto, during the spring, operations appear to be progressing favorably at the present time. The Hamilton Bridge Company have taken back many of the men whom they laid off some weeks ago, and there are now about 50 of them at work on the structure.

The city of London requires to have its water supply increased by 2,000,000 gallons or more, and for that purpose the Utilities Commission have been experimenting with artesian wells. It is thought that the fields near the present pumping station at Horton Street can perhaps be developed sufficiently to serve the city for some time to come.

The Standard Ideal Plant at Port Hope, Ont., has been sold to L. M. Wood, president of the Standard Chemical Company, and his associates, amongst the number being W. D. Ross, formerly general manager of the Metropolitan Bank, and Cuff Brothers, Toronto. The new company will take possession at once, and, in addition to carrying on the present line of business, may engage in the manufacture of shells.

The net profits of the Ontario Steel Products Company, Ltd., for the year ended July 30 last, after depreciation, etc., but before bond interest, amount to $152,019, an increase of about 100 per cent. over the 1914-15 showing. The balance available for dividends was $116,019, an increase of $76,274, or 192 per cent., as compared with the corresponding balance in 1914. This balance represented earnings at the rate of 15.5 per cent. on the preferred stock.

At a recent meeting of the Council of Aylmer, Ont., James O. Meadows, sanitary engineer, of the Montreal Light, Heat and Power Company, to whom the contract has been awarded, presented the plans for a new filtration plant. The plans were favorably received by the Council, and were submitted to the Provincial Health Department for approval. If reported satisfactory the work of installing the plant will be got under way in a short time.

E. A. James, highway engineer of York County, Ont., recently stated that excellent progress is being made on the good roads system at the four different points where work

is being carried on. One gang is at Bond Lake, on Yonge Street, a second south of Woodbridge, and a third on the Kennedy Road, at Ellesmere. The fourth gang are working easterly from the fifth concession of Markham, and later will work west on the Langstaff side road toward Yonge Street.

The building laborers of Winnipeg are organizing a union. A mass meeting was recently held at Labor Temple, President Veitch of the Trades Council occupying the chair. J. Magnusson was elected president and Matthew Davey secretary. The finances of the new organization will be in trust of the Trades Council until the body is firmly established. A wage scale of 30c per hour and nine hours a day is likely to be established as the union rate.

The Essanay Film Company of Chicago have just completed a series of motion pictures showing the electrification of the mountain division of the Chicago, Milwaukee and St. Paul Railway System. These pictures were projected in the Regent Theatre, Ottawa, Ont., on Tuesday, August 1, under the auspices of the Canadian Society of Civil Engineers. A large number of members availed themselves of the opportunity of seeing this great project through the medium of motion pictures.

The Canadian Copper Company have before them a building programme which includes the erection of 55 houses, one club and one boarding house at Creighton Mine, 27 houses at Copper Cliff, and 23 houses and one boarding house at Crean Hill. Eight houses will also be moved into Copper Cliff from Frood, and an addition will be built to the Crean Hill school. Dickie Construction Company, Toronto, have the contract for the Copper Cliff and Creighton work and the Laberge Company for Crean Hill. The houses will all be frame and will range from five to eight rooms.

The demolition of the Parliament Buildings at Ottawa is now complete, with the exception of the library. The sections of solid walls which were left standing after the fire, and which were valued by the architect at $2,000,000, including the fireproof wing, have all been wiped out. It is stated that there is some dissatisfaction amongst the members of the committee appointed to supervise the business at this method of procedure, as a considerable increase in cost is likely to result; it was the understanding at the outset that the standing walls should be utilized in the reconstruction.

The superstructure of the Quebec bridge has now been practically completed, and the placing of the central span remains as the last unit of the work. This span, which is 640 feet in length and weighs some 6,000 tons, is now being built on false work, and is to be floated into position on barges when completed. The large traveller used on the north side of the bridge was taken down last spring and re-erected just below Pointe aux Pizeau at Sillery, where it is to be used to place the central span on the barges. These barges, six in number, are being constructed at Sorel, and are all to be delivered at Sillery by the middle of this month. The contractors, the St. Lawrence Bridge Company and the Canadian Bridge Company, hope to place the central span in position some day between the 10th and 15th of September.

A contract has been awarded to B. Kerr for the construction of three infiltration basins at the Point Edward plant of the Sarnia waterworks, with connecting valves and pipes, at a cost of $5,280. These basins will be 12 by 18 feet by 15 feet deep, and will have no bottom. They will be constructed of concrete, with tops of plank. Each will have a 10-inch outlet pipe, which will run into a main of 24 inches. The 24-inch pipe will lead into the nineteenth basin of the old infiltration system, and the water will be chlorinated before it is allowed to enter the old basins, where the water is pure for consumption. The three basins will be constructed on the surface and will then be sunk to the proper level by excavating the material from the inside. Campbell & Co., of London, have purchased a hoist from Gutteridge & Grace, and are removing the gravel from the waterworks site.

Members and officials of the city and rural councils forming the Greater Winnipeg Water District and a number of citizens of the respective boroughs recently inspected the operations on the Shoal Lake aqueduct, as the guests of the administration board. Stops were made at several of the camps where work is in progress, and the vistors were thus enabled to see the great pipe line in process of construction, from the dredging of the trenches to the refilling. The effects of the recent heavy rains, which have caused the contractors much delay and expense, were also seen, though by means of gasoline pumps and dams the water had been almost all removed. The aqueduct has been successfully completed across the head of that section of Indian Bay that was dyked off to prevent contamination of the bay at the intake by the turpid waters of the Falcon River. It is stated that the contractors are experiencing labor difficulties, as the men have been leaving on the prospect of making more money in the harvest fields. A modification of the construction programme for this year may result on this account.

Personal

Mr. C. J. Wilson, formerly with the Algoma Steel Corporation, has been appointed superintendent of the mechanical and engineering department of the Donner Steel Company, Buffalo. Mr. Wilson was with this corporation for fourteen years, having entered their service in 1901 as foreman electrician. Some time later he became superintendent of the electrical department then assistant to the general superintendent, and finally assistant to the general manager.

D. Lytton Macdougall, an engineer of wide railway experience, recently enlisted with the Railway Construction Corps. Mr. Macdougall has lately been engaged in appraisal work for the United States Government on the Old Dominion Railway of Virginia, and upon completion of his task immediately came to Canada to volunteer. He spent seven years as engineer with the Chesapeake and Potomac Telephone Company, of Baltimore, five years with the National Transcontinental Railway during the construction period, and was locating engineer for the Alberta and Peace River Eastern Railway, a project of the late Duke of Sutherland.

Obituary

Mr. Clark Gordon of Sherbrooke, Que., died recently, at the age of 80 years. Mr. Gordon was a contractor, and built a section of the Canadian Pacific Railway.

Owen Davies, senior partner of the firm of Owen Davies & Son, roofing contractors, died at his home in Winnipeg recently. Mr. Davies was a native of Wales, and settled in Winnipeg in 1822.

The death occurred recently in Toronto of Mr. John L. Johnston, at the age of 75 years. Mr. Johnston spent his youth in Cannington, and moved to Toronto some 35 years ago, where he carried on the business of general contractor.

Mr. J. T. Schell of Alexandria, Ont., well known in Glengarry County as a man prominent in its business and public life, recently passed away. Some large contracts in railway construction were put through by him, amongst which was about sixty miles between Ottawa and Hawkesbury, Cape Rouge, Quebec.

Mr. Robert McCallum, former city architect of Toronto, died on August 2, at his residence, 187 Madison Avenue. Mr. McCallum was born in Toronto 65 years ago, and received his education at the old Grammar School and old Upper Canada College. He was a civil engineer in the employ of the Ontario Government for 21 years, and entered the employ of the city about 1903, retiring some ten years later on account of ill-health.

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Waterworks and Sewerage Issue

THOUGH this number is specially devoted to discussions of waterworks and sewage problems, it is not suggested that these two subjects, or either of them separately, could be treated exhaustively within the range of one single issue. Indeed, our idea has rather been to attract the attention of those readers of the Contract Record who may not have given this subject very much thought, to the tremendous importance attaching to a supply of pure water in the interests of the conservation of the life and best energies of our public citizens. At the same time we have hoped to be able to add something of value to the knowledge of those specially interested in the subject—something further in the way of ammunition with which waterworks and sewage engineers and superintendents, city engineers, and others having the welfare of their respective communities at heart may batter down the walls and tear up the opposing trenches of ignorance, penuriousness, or indifference not infrequently met with in municipal bodies.

* * *

There has doubtless been in the past a lamentable dilatoriness in the installation of proper water cleansing and sewage disposal systems throughout Canada. Perhaps it is that our people must be still further educated up to the advantages of preventive measures in maintaining public health; perhaps the uncertainty attached to the relative advantages of this or that system of purification has bred distrust; perhaps our engineers, knowing the will of the people and their elected representatives to economize in expenditures, have not been sufficiently aggressive in demanding what they knew to be a public necessity; perhaps the medical fraternity, naturally looked upon as authority in matters concerning the preservation of public health, have hesitated, with their usual reticence, to advocate the use of pubilc moneys to prevent diseases which their training specially fitted them, for a consideration, to cure; perhaps it is that the higher standard of public living, so much in evidence in the outward appearance of our citizens, is just beginning to experience a renaissance in the inner man; perhaps it is because trade journals have been lax in their duty of forcing these matters on the attention of their readers—whatever the cause of past laxity, there can be no doubt of the present facts, that a very large percentage of our civic populations are daily exposed to dangers that threaten their good health, dangers that might be removed by the expenditure of a sum of public money which, though in the aggregate it may sound considerable, actually works out at a very small insurance premium per capita. If in this issue we are instrumental in helping to remove any of the causes that have stood in the way of better public health, our object has been attained.

* * *

But though the chief interest in a waterworks and sewage discussion must necessarily centre round the purification of water and sewage, there are many auxiliary considerations, such as the various methods of purification, structural details of the purification plants, the water distribution system, the sewage collection system, and so on. Enough of these matters has been included in this number, we believe, to make it of interest to the contractor and the construction engineer. In this connection we may mention an article dealing with some of the constitutional problems met with and overcome in the erection of Toronto's new water filtration plant, a work entirely unique on account of the unusual local conditions surrounding the plant's site. Similar articles are those dealing with the sewage system of a typical city and the combined waterworks and sewerage system of Mimico. We also are indebted to a number of city engineers, waterworks superintendents, and other officials at various points in the Dominion, for descriptions of the plants in which they are locally interested. These will be read with great profit, as representing the experiences, in their own words, of practical men.

Water Supply Systems of the Dominion

Brief Review of Extent to Which Water Purification is being Practised by our Canadian Municipalities

AN increasing number of urban and rural centres of Canada are recognizing the urgent necessity of a purer and more adequate water supply. This is due, no doubt, in part, to the rapid growth of large centres of population, coupled with the ever-increasing difficulty of keeping the sources of supply free from pollution. But it is also gratifying to note that our public bodies are recognizing more fully the value of preventive methods of maintaining the public health, as our medical authorities are unanimous in their opinion that an impure supply of water is responsible for a very large percentage of the ills and sicknesses from which we suffer.

Contamination

The problem of a supply of pure water is, of course, inseparably tied up with that of sewage disposal. Most of our water supply sources were, originally, fairly pure. Water contamination, however, is a necessary adjunct of more thickly populated areas where, often enough, the disposal of sewage has been carried on by one municipality with entire disregard for the comfort or health of another. Such, for example, is the case where sewage has been dumped by one town into a river which a little lower down becomes a source of water supply of a neighboring town. This not only imposes on the second town the necessity of a water purification plant to remedy a condition for which it is in no way responsible, and which should never have been created, but it jeopardizes the health of the citizens who use this water for daily consumption. A well-known authority recently made the statement that, "if the domestic sewage, which now discharges by means of underground sewers directly into streams, rivers and lakes, without any form of treatment, were treated to the extent of the elimination and destruction of the sewage bacteria, at least 1,500 lives could be saved annually in Canada from death by typhoid alone." When one considers that the percentage of fatalities from typhoid is comparatively small, it is evident that, quite in addition to the loss and sorrow caused by the death of 1,500 good citizens, there is a tremendous and unnecessary outlay of money and a very great loss of time and waste of energy by the larger percentage of typhoid victims who recover and by the people necessary to wait upon them, all of which might be prevented by the establishment of a proper system of water purification.

Heavy Expenditure Entailed

That the municipalities of the Dominion of Canada are realizing their duty to the public cannot be shown better than by the large money expenditures that are being made for this purpose at various points throughout the country. The main difficulty in connection with water purification work is that it entails very heavy expenditures—larger, indeed, than many municipalities consider themselves able to undertake. Where the necessity is shown, however, these sums, though large, should not be placed against the valuable lives of our citizens.

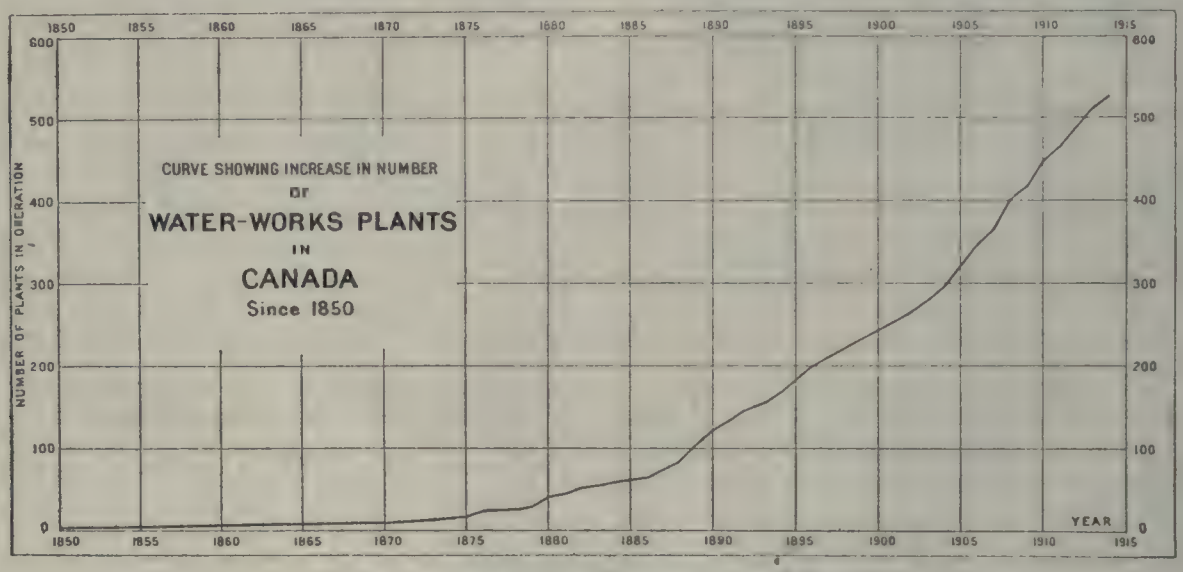

Fig. 1—Curve showing number of waterworks plants in Canada.

That the number of waterworks plants is increasing very rapidly in Canada is shown in the accompanying diagram, Fig. 1, which dates back to 1850. This diagram is the result of figures recently gathered by the Commission of Conservation. From it we see that up to the end of 1914 approximately 525 municipalities (528 to be exact) had installed waterworks plants of one kind or another. Of this number 93 are treated, or 17.6 per cent.

It is interesting to note how these waterworks plants are distributed—Nova Scotia has 33; Prince Edward Island, 3; New Brunswick, 20; Quebec, 177; Ontario, 166; Manitoba, 13; Saskatchewan, 30; Alberta, 33; British Columbia, 53. Further information is given in Table 1 herewith, from which we learn also the various sources of supplies. From springs or wells

there are 206 municipalities supplied; from distant lakes or streams, 106; and from lakes or streams which are possibly polluted from one source or another, 216. Evidently, then, Canada should have at least 216 water purification systems instead of 93.

Of the 93 water purification plants, Table 1 shows us that 72 use some form of filter and the remaining 21 use hypochlorite of calcium. There is one exception—Longueuil, Que.—where calcium hyposulphite is substituted. There are also a small number of municipalities where sedimentation or settling tanks or basins are in use—some as the only means of purification, others merely as auxiliaries to further purification methods.

Some of these sedimentation basins are natural reservoirs utilized at little expense. Others are rectangular basins with horizontal walls varying in depth and size depending on the condition of the water and the quantity demand. Where it can be had at small expense, a settling basin is generally considered a valuable adjunct of any purification system.

Province	No. of Plants Supplied from:			No. of Plants using		Mode of Supply		Kind of Power where Pumping is Used							Owner ship		Rates on which Charges are Made		
	Springs or Wells	Lakes or Streams: Distant	Lakes or Streams: Possibly Polluted	Filters	Hypo.	Gravity	Pumped	Water Power	Steam	Electric	Gas	Gasolene	Oil	Wind	Municipal	Private	Flat	Meter	Both F. and M.
Nova Scotia	7	25	1	[illegible]	.	22	11	2	[illegible]	1	.	..	..	..	30	3	[illegible]	..	11
Prince Edward Island	3	.	..	.	.	1	2	.	2	.	..	..			2	1	.	..	2
New Brunswick	10	7	3	1	..	9	11	..	4	4	2		.	1	18	2	13	.	6
Quebec	76	29	72	19	10	93	84	10	27	29	..	5	..	7	102	75	46	1	19
Ontario	66	6	94	27	10	23	143	18	[illegible]	41	[illegible]	3	2	1	148	18	76	6	70
Manitoba	6	1	6	5	..	2	12	..	5	2	2	2	1	..	13		1	6	3
Saskatchewan	21	2	7	6	..	6	24	..	4	11	2	4	3	..	30	.	10	11	4
Alberta	9	5	19	10	1	11	[illegible]	..	16	[illegible]	[illegible]	1	1	..	24	9	10	4	12
British Columbia	8	31	14	[illegible]	..	46	7	..	3	3	..	1	..	..	29	24	33	2	14
Canada	[illegible]	106	216	72	21	213	316	30	135	93	16	16	7	9	396	132	209	[illegible]	141

Table I.—Showing various data in connection with Canadian waterworks plants.

Filters

The Canadian filtration systems include everything from a natural sand and gravel "soakage" to the most modern mechanical or "rapid" filtration system. At Claresholm, Alta., for example, is a good example of the former, where the water is drawn through a gravel bed and taken out at a point 150 feet distant from the river. At Pincher Creek, Alta., the water also is drawn through the gravel bank of a creek. In Redcliff, Alta., the water passes through 2,000 feet of gravel. At Red Deer, Alta., the wells from which the water is pumped are provided with cinder filter walls.

A considerable number of municipalities also combine some form of chemical treatment with their filtration, the particular chemical used depending on the condition of the water. Most frequently the water is first treated with chloride of lime; aluminium sulphate and ferrous sulphate are also used. In St. Catharines, Ont., the method of purification consists of a sedimentation basin, supplemented by treatment with chlorine in the liquid form. Of the treatment by chlorine in one form or another, a method of water purification which has been very freely adopted on this continent within the past few years, it may be said that the chief objection is the noticeable smell and taste necessary if sufficient of this chemical is used to be certain of the destruction of all the bacteria. It may be said in a general way that if there is no taste or smell to the water, it is an indication that the bacteria have not been destroyed with certainty. As a permanent treatment, therefore, it will always remain open to objection, though it would be most unwise not to immediately resort to its use in cases of emergency.

Principle of Filtering

The two principal classes of filters are the slow sand and rapid or mechanical filters. Various installations under different names are merely modifications of one or other of these—generally the slow sand—to meet the designs of some engineer or manufacturer. In principle they remain the same. A filter, in general, consists of layers of filtering material, generally sand, through which water is passed for the purpose of removing bacteria and other suspended matter. These layers are supported by an under drainage system. The filters act primarily as strainers, though the finest particles of silt and the very largest bacteria are greatly inferior in size to the smallest sand grains. However, the removal of fine suspended matter, including bacteria, is accomplished in part by the absorbtive power of the surface film which surrounds each sand grain and in part by the film which condenses on each particle of suspended matter. These latter films tend to coalesce with the films surrounding the sand grains. It was formerly thought that the surface layer of sand accomplished the removal of all the suspended matter, but experience has shown that thicker beds are steadier in operation, from which it is now believed that each layer of sand plays a more or less important part in the removal of suspended matter; of course, the greater part of the suspended matter is always removed in the surface layer of sand.

Rapid and Slow Sand Filtration

Slow sand filters differ from rapid filters in that the rate of filtration is much slower and the filter

can only be cleaned by removing the superficial layer and washing and replacing. In the most modern type of rapid or mechanical filtration, the Ransome, the washing process is continually taking place. The action of the slow sand filtration is rendered still slower by the coating which gathers on the upper surface of the filter and prevents the passage of the water through it. This also applies to some "rapid" forms, but is avoided in the Ransome form of filter, in that the surface of the sand is continually being moved and cleansed. In the general "rapid" type the water is passed through under considerable pressure. No pressure, however, is used in the Ransome. The rate of filtration in mechanical filters is sometimes as much as fifty times that employed in the slow filter.

There is no very great variety to choose from in the methods of water distribution adopted by municipalities. For the most part cast iron or wrought iron pipes are used (very occasionally steel) for mains, and galvanized iron and lead pipes for services. In Western Canada a quantity of wood pipe has been installed, these being available either in the form of wood stave pipes, 2 inches in diameter and up, or bored from the solid timbers. These pipes have generally been treated and water-proofed, and are reported as having a long life.

Sewerage Systems of the Dominion

Resume of Status of Sewage Disposal and Treatment Processes as Practised in Canada

THE effective disposal and treatment of sewage is a problem of economic importance, incident upon the grouping of people into municipalities. The importance of this question can scarcely be over-estimated, since in connection with it is involved so much that concerns sanitary conditions. Careful disposal and purification of sewage wastes is one of the greatest factors in maintaining and safeguarding health. The fact that in the majority of instances raw sewage is discharged, unpurified and untreated, into a water supply contributes in a very great degree to the unhealthy conditions of many communities.

The question of stream pollution is becoming very serious in Canada. As proof of this, investigation has shown that 183 municipalities in Canada dispose of their sewage in raw, untreated form, by discharging directly into inland waters. This figure means about 66 per cent. of the places that have any sewerage system at all. From most of these waters other communities draw their water supply, placing their intakes below the discharge outlet for sewage. It has been found that 40 per cent. of the waterworks plants in Canada draw their supplies from sources that are possibly polluted. This indicates the extent to which the practice of stream pollution has developed and the danger to which people are subjected through improper handling of sewage. The methods of sewage disposal and water supply are thus intimately related. In many instances municipalities have utterly disregarded the welfare of other places in the matter of discharging putrescible sewage into a source of water supply.

More Interest Being Shown.

That this matter is receiving more of its due attention is evidenced by the increasing interest shown in this connection. Expenditures have been authorized for the construction of sewer systems and sewage purification works, and many plans are being prepared for more or less comprehensive lay-outs. All over Canada a greater realization is being felt that a sanitary method of gathering and disposing of sewage waste is of paramount importance from a health standpoint alone.

Many methods are available for disposing of and purifying sewage. Local conditions to a large extent govern the methods to be adopted in any particular instance. These might be such that sewage can be discharged untreated into a body of water when it is known it will not be used as a source of water supply. On the other hand, conditions may be such that a combination of methods may be advisable. The problem for the engineer is, then, to determine to what extent purification must be perfected and to design a method that will most effectually carry this out.

The accompanying table classifies the sewage systems in Canada, as far as has been determined by careful investigation and analysis. It will be noticed that in the entire country only 279 communities have any method by which they remove their sewage. This is remarkably small in comparison with the total number of towns in Canada, due, no doubt, in part to the heavy expenditure which the construction of sewage systems involves. The capital lay-out necessitated is, in general, greater than smaller places care to spend.

In some places the method in use is to employ one set of sewers to carry domestic sewage, street drainage and storm overflow. In others separate systems are installed. One hundred and fifty-five towns employ the combined method, while separation is carried out in 124 places. By provinces the number of sewer systems is as follows: Nova Scotia, 20; Prince Edward Island, 2; New Brunswick, 10; Quebec, 98; Ontario, 95; Manitoba, 9; Saskatchewan, 15; Alberta, 14; British Columbia, 16.

The total mileage of pipe included in these systems is 4,223 miles. involving an outlay of $74,504,418.

Sewage treatment with the object of rendering the effluent harmless and free from disease-spreading bacteria is carried out in only 75 cases, representing 36.3 per cent. of all the municipalities which possess sewerage systems. The three maritime provinces have no purification systems at all, sewage in these cases being discharged directly into rivers or bays. The Western provinces show the greatest proportion of treated sewage works. In Saskatchewan 80 per cent. of all systems are treated; in Alberta 43 per cent.; in British Columbia, 44 per cent. In Ontario about one-third of the towns purify their sewage, and approximately one-eighth in Quebec. The total value of the treatment plants in Canada is $3,218,935.

Sewer Pipes.

Sewage systems show no great variation as regards their distribution pipes. Tile pipes are the accepted standard for all small and many large installations. In the larger towns, where the size of the pipe lines is sufficient to warrant it, brick and, to a lesser extent, concrete are freely employed as materials for sewer construction. Cast iron and steel occur in rare in-

stances. Wooden sewers have been installed in four or five towns. St. John, N.B., possess 11½ miles of this type in various sizes, and Winnipeg has 1¼ miles, while other places have lesser amounts.

Plants for the treatment and purification of sewage wastes show more variation in design and manner of operation, and very many systems have been evolved to effectively carry out purification. Local conditions, as well as initial cost, govern to a large extent the particular type which any town will select, and the degree of purification desired will determine the extensiveness of the system.

In the towns and cities in Canada which employ methods of treatment, illustrations are afforded of practically every well-known process, from the simplest to the more extravagant. In many cases, where conditions warrant, a combination of systems is made use of, purification increasing with each step.

Sterilization.

Two or three municipalities merely render their sewage sterile by means of chemical treatment with hypochlorite of lime. This is simply a disinfecting process, and does not aim at separating the solid materials from the liquids. The number of organisms is reduced to such an extent, however, that the discharge is not of exceptional danger. Bleaching powder is also used to sterilize the effluent from other purification processes, in this way rendering it non-putrescible, so that it can be safely discharged into a stream which is the source of water supply for another community.

Sedimentation.

Sedimentation methods are very often employed in Canadian towns. By this system sewage is allowed to flow through tanks at a velocity sufficiently low to ensure practically all the suspended matter settling in the form of a sludge. Sedimentation tanks require frequent cleansing to remove the solid accumulation before it begins to decompose and rise through the sewage, and thus get carried out with the effluent.

Chemical precipitation is sometimes made use of. The addition of alum or ferrous sulphate causes precipitates, which settle, carrying with them bacteria and solid matter. If the effluent from a settling basin is to pass into a source of water supply it should be sterilized by chloride of lime.

Septic Tanks.

Septic tanks in some form or another are particularly popular. Of the 75 purification installations in Canada 40 employ this arrangement, either in conjunction with further processes or alone. These tanks are simply covered chambers, in which the sewage is allowed to decompose. Operation is carried on in such a manner as to encourage the growth of anaerobic bacteria which decompose the sewage, without causing unpleasant smells. The result is a clear liquid and a black sludge resembling, often, vegetable mould. The decomposition is accompanied by the production of large quantities of gas, due to biological action, which is retained until the mass becomes sufficiently buoyant to rise rapidly to the surface, which often gives the tank the appearance of ebullition. Sewage requires 12 to 24 hours' treatment to effect decomposition.

The Imhoff tank, used in several instances in Canada, is an improved septic tank, in which the sewage is allowed to pass through the sedimentation chamber as rapidly as the suspended matter can settle. The sludge decomposes in a chamber separate from that in which sedimentation takes place. This results in an effluent which has not come in contact with the decomposing sludge, and which does not hold the suspended matter common to effluents of the septic tank. Tanks of this nature are ideal for small communities, and their popularity is evidence of effectiveness for the purpose.

In 18 cases extra treatment is involved, either in conjunction with or supplementary to the septic tank purification. In a number of instances the effluent is subjected to filtration to render it sterile. In others chloride of lime is used to accomplish disinfection. Very many of the towns have a combination of the septic tank arrangement, with filter beds of various types, as described below.

Contact Beds.

Filters of this type are built in water-tight compartments, filled with broken brick, stone, or similar

Province	Sewers				Sewage Treatment		
	No. of Systems		Total No. of Miles	Total Cost (dollars)	No. of Systems Where:		Cost of Treatment Plants (dollars)
	Combined	Separate			Not Treated	Treated	
Nova Scotia	16	4	153	1,716,590	20	....	
Prince Edward Island	....	2	28	175,000	2	..	..
New Brunswick	5	5	123	1,101,062	10	....	.
Quebec	60	38	829	20,861,531	86	12	[illegible]
Ontario	54	41	1,670	24,195,834	60	35	1,774,287
Manitoba	5	4	335	6,084,736	8	3	116,291
Saskatchewan	3	12	237	3,623,962	3	12	694,485
Alberta	7	7	407	7,896,477	8	6	131,300
British Columbia	5	11	441	8,849,226	9	7	113,572
Canada	155	124	4,223	74,504,418	204	75	3,218,935

Table showing distribution and types of sewage plants in Canada.

medium, to a depth of three to five feet. The surfaces of the stones become coated with a gelatinous bacterial medium, which effects purification in much the same manner as a sand filter for water. Decomposition takes place rapidly, and the effluent is usually non-putrescible. A contact bed must be operated with plenty of air, because all reactions are aerobic in nature. Contact is usually from two to six hours, and it is excellent practice to have a second contact in a secondary bed. The capacity is about one to two million gallons per acre per day.

Sand Filter.

The intermittent sand filter consists of a bed of sand from three to five feet deep. Sewage is spread on the surface and percolates through the sand. The biological processes are analagous to those in the contact bed or a water filter. In a well-constructed filter of this type oxidation is carried nearly to completion. The primary objection is that operation is necessarily slow. The retention of the suspended matter on the sand also materially reduces the capacity and, in time, the filter will be impervious to water. Frequent cleaning is necessary, therefore ,to remove the mat from the surface of the sand. Sedimentation before filtering reduces the need of cleaning to quite a large extent. In many cases, therefore, we find a combination of septic or sedimentation tank with a sand filter.

Trickling or Spraying Filters.

In this type of filter, coarse grained stone is used as in the contact bed, but careful underdraining is required. The sewage is distributed as uniformly as possible over the surface of the bed by spraying arrangements or revolving sprinklers. By the bacterial film which is built up the sewage is deprived of its putrescible, organic matter. The rate of feed of the sprinklers is so arranged that operation is practically continuous ,and thus there is a distinct advantage over the contact bed, which must be dosed and aerated periodically. In an efficient trickling bed a very clean effluent is produced, and the number of bacterial organisms is considerably reduced. The beds should be so constructed that the solid materials shall not accumulate indefinitely in the stone, but may wash out, avoiding the necessity of removing the stone to wash it. Great importance is attached to the underdrainage system which carries away the effluent. Its speed is rapidly bringing this system into use. Four towns in Canada are using this method in conjunction with septic or sedimentation tanks.

Examination of all of Canada's disposal systems shows that the septic tank exceeds all others in popularity. In most cases an added treatment is involved, usually in filter beds of one of the types spoken of above. In some instances chlorination is carried out after these two processes. Sometimes chlorination is used directly after a septic treatment. Sedimentation, either alone or in conjunction with filters, is of frequent occurrence, and filtration alone finds favor in some instances. A large proportion of Western towns, in particular, are installing very modern and efficient methods.

Aeration.

The question of aeration is an important feature in a treatment system. The solid sludge requires contact with the atmosphere to produce the oxidation necessary to render it harmless. Air and sunlight contribute very materially to the growth of those aerobic bacteria which assist the processes of oxidation and which break up the solid, offensive materials into harmless mineral materials. Aeration can be carried out in large beds, where the sludge is spread out to the action of both air and sunlight. Filter processes, as above described, are essentially aerobic systems. The Imhoff tank, on the other hand, depends for its effectiveness on the anaerobic bacteria, which thrive in dark and unventilated places. On this account the sludge developed by such a method should be thoroughly aerated to insure its being free from harmful or disease-producing organisms.

A new system has recently been developed for treating sewage, in which sedimentation and aeration play a most important part. The activated sludge process, as this is called, gives great promise of extensive development and efficient service. As yet we cannot give definite information regarding its suitability in Canadian towns. It is to be hoped that experiments will demonstrate its usefulness in assisting Canadian towns and cities to improve their sanitary standards.

Some Aspects of the Water Supply and Sewerage Situation in Canada

By Leo. G. Denis*

IN Canada, as in many other countries, problems connected with water supplies and sewage systems bear a very close relation to each other. In most of the smaller centres of population the waterworks and sewers are directly under the same management; very often the two systems have been installed together, the same trench serving for both systems of mains. In the extension of our older cities into new districts or subdivisions the two conveniences are usually required and installed at the same time. In all of these and many other respects the systems rather help one another in their operations; but, unfortunately, one of the most important relations is that of interference where a stream or other body of water, once a pure source of water supply, becomes grossly polluted by sewage.

The question of stream pollution is becoming very serious in this country, attention to this being called in a recent report on "Water Works and Sewerage Systems in Canada," published by the Commission of Conservation, in which it is shown that more than sixty of our inland water systems are at present receiving sewage without the least attempt to prevent it spreading diseases, 180 municipalities contributing to this very undesirable state of things. A careful study further reveals the fact that from most of these polluted water systems municipalities draw their water supply, the intakes being situated at points below where the pollution takes place.

It is to be noted, however, that conditions in this respect are rapidly improving, this being particularly the case in the western portion of the Dominion. If we take the different provinces on a per cent. basis we find the following: In Ontario, of the total number of municipalities having sewerage systems, 37 per

* Commission of Conservation.

cent. treat their sewage; in Quebec we only find 12½ per cent. treating their sewage; in Manitoba, 53 per cent., while in Saskatchewan we find 80 per cent.; in Alberta 43 per cent., and in British Columbia 44 per cent. The Maritime Provinces cannot be placed on the same basis, as most of the sewerage systems discharge directly into the ocean and treatment would be superfluous. For the same reason the figure given for British Columbia does not offer a fair comparison with inland provinces.

The better conditions with regard to sewage disposal in the West is greatly due to the systems having been more recently installed, after the necessity for treatment had become apparent to all. The systems in the Eastern Provinces have, in the majority of cases, been installed before sewage treatment had become so universally recognized, and, not being laid out for this purpose, it is, in some cases, rather costly to make the change. However, marked improvement is also to be noted, and practically all new sewerage systems either have treatment plants or are designed and installed with the view of having treatment plants added in the near future at the least possible expense.

Importance of Pure Water

This tendency is only natural, as the supply of water to communities is the most important use of inland waters, and the value of a pure supply, as compared with one polluted by sewage, can scarcely be over-estimated. Even where water systems are provided with filtration plants, there is a great danger of overloading the filters if the source of supply is grossly polluted by raw sewage. The use of water filters should be only an additional factor of safety in an operation which should begin with the proper treatment of sewage. A striking example of this is afforded by the recent typhoid epidemic in one of our Western cities. Although the water supply was chlorinated, the cause of the epidemic was declared due to its polution. It seems that the degree of chlorination which would have been ample under normal conditions, was insufficient under conditions alleged to have existed owing to gross pollution.

The erroneous statement is sometimes made that the benefits derived from sewage treatment, great as they may be, are too costly; that it may be worth while in European countries, but that Canadian conditions are quite different. The best answer to this is found in a recent report upon remedial measures for the present conditions of pollution of boundary waters between Canada and the United States. The report contains estimates of cost for some 27 Canadian and United States cities and towns in the Detroit and Buffalo districts, which show that, including fixed charges and operation, the average cost for sewage treatment would be 61 cents per capita per annum. Any citizen should willingly contribute this small amount to help in the restriction of a nuisance of which he is the cause, otherwise our civilization is lacking in some respects.

Typical Sewerage Systems

Probably the best-known sewerage treatment plant in Canada is the one at Lethbridge, Alta. The mode of treatment is by sedimentation, sprinkling filters, and chlorination. the disposal plant having cost $90,000. Among other plans mentioned in the Commission of Conservation report we find septic tank treatment and filtration used at the following places: Stratford, Ont., where the disposal plant has cost $60,000; Weston, Ont., where the plant has cost $21,000; Souris, Man., where the plant has cost $28,000. Berlin and Guelph use this same treatment, as well as Hamilton, the latter having Emscher tanks and chemical precipitation in addition, the total cost of treatment plants in this city being $280,000. In Toronto chlorination and sedimentation tanks are used, the disposal plant and trunk sewers in connection with it having cost $2,792,000. Montreal, so far, only treats a portion of its sewage by intermittent filtration, the cost of the plant and its proposed addition being $450,000. Imhoff tanks and filtration is used in Simcoe, Ont., Estevan, Sask., and Kelowna, B.C., the costs of the treatment plants being $34,000, $30,000, and $17,000 respectively. The Stoddard system, with sedimentation tanks or basins, is used at Moose Jaw and Yorkton, Sask., the treatment plants having cost $195,000 and $28,000 respectively. Regina uses sedimentation, filtration, and chlorination, the cost of the disposal plant being $230,000, while filtration is used in Cranbrook, B.C., where the treatment plant has cost $19,000.

Water Purification and Disinfection.

Water filters are used in connection with many Canadian water supply systems. According to recent statistics, filters have been installed in connection with 27 systems in the Province of Ontario, 19 in Quebec, 10 in Alberta, 6 in Saskatchewan, 5 in Manitoba, and a total of 5 for the remaining provinces. In this connection it is of interest to note the number of plants in each province obtaining their supply of water from lakes and streams which may be polluted, or, in other words, to compare figures giving an idea of the number of cases where some mode of water purification should be used. We find 94 of these in Ontario, 72 in Quebec, 19 in Alberta, 7 in Saskatchewan, and 6 in Manitoba. Of course, most of the systems not possessing filters disinfect the supply with hypochlorite or similar treatment. With regard to this it may be stated that, while it would be most unwise not to resort to water disinfection in cases of emergency as a solitary treatment, it cannot be considered a permanent method. Statistics given at a recent meeting of the American Waterworks Association emphasize this point. Out of 110 plants is Canada and the United States only 37 per cent. use disinfection without other treatment. The balance, or 63 per cent., only use it as an additional safeguard to some other treatment, in most cases filtration. It seems everywhere recognized that there are certain times when the hypochlorite treatment is less satisfactory than others. This is shown principally in the appearance of tastes and odors that occasion complaint among consumers, or in a low and unsatisfactory removal of bacteria by the treatment.

The use of liquid chlorine is an evolution of the process of disinfection by chlorination, and it is stated that on account of advantages it possesses the latter is gradually being supplanted by the liquid method. However, it is well to note that, although water disinfection has met with great success, it cannot be considered as a substitute for filtration where both turbidity and bacterial problems are involved and the limit of its proper function should be as an auxiliary to filtration, or as an emergency measure to render unfiltered supplies safe.

Sand Filtration

Both slow sand and mechanical filtration are used in various Canadian water-supply systems. Among the more important installations in operation or under construction we find the slow sand method at Midland, Owen Sound, Perth, Port Hope, Ont., and Westville, N.S.; both slow sand and mechanical methods

are found in Montreal and Toronto, while mechanical filtration has been adopted in Chatham, Dundas, Haileybury, Orillia, Renfrew, St. Thomas, Stratford, Ont.; St. Hyacinthe, Shawinigan Falls, Verdun, Que.; Fredericton, N.B.; Brandon, Man.; Prince Albert, Saskatoon, Sask.; Edmonton and Medicine Hat, Alta.

The greater number of systems making use of mechanical filtration would tend to show that this mode of treatment held the preference. It must not be forgotten, however, that the great activity of mechanical filter manufacturers in placing their products may have had a marked influence in increasing the proportion of these used.

A large number of our Canadian waterworks have the advantage of obtaining their supply from sources where the danger of pollution is far remote and where filtration is usually unnecessary. Supplies obtained from springs or distant lakes and streams are referred to, these being generally at a high enough elevation to use gravitation as the mode of supply. If we also include plants supplied from wells in this class we find the following number of systems obtaining fairly pure water directly from their source of supply: Quebec, 105; Ontario, 72; British Columbia, 39; Nova Scotia, 32; Saskatchewan, 23; New Brunswick, 17; Alberta, 14; Manitoba, 7; Prince Edward Island, 3; giving a total of 312 for Canada as against 216 plants obtaining water from possibly polluted sources. Many important systems in the Dominion are supplied by gravity from distant sources. Among these may be mentioned Halifax, which obtains its supply from Long and Spruce Hill lakes, 4 miles and 7 miles distant respectively; Sydney, N.S., supplied from Sullivan Brook, 3 miles distant. St. John, N.B., possesses one of the earliest gravity systems of importance in Canada; the first installation, which dates back to 1837, has since been materially improved and extended. The principal supply at present is taken from Loch Lomond, 10 miles distant, which has a surface area of 2,480 acres and lies at an elevation of some 300 feet above the city high-water datum. The Quebec city supply is also among the early gravity systems, the St. Charles River, 9 miles distant, having been used as a source of supply for a great number of years. By a strange coincidence, Fort William, Ont., as St. John, N.B., receives its gravity supply from a Loch Lomond. It is a fairly recent installation, and in this case the Loch, which is 7 miles distant, has an area of 9 square miles.

Water Supply for Western Towns.

Calgary, Alta., obtains a portion of its supply by gravity from the Elbow River, the intake being at a point 14 miles from the city. New Westminster, B.C., has a gravity system from Coquitlam Lake, 14 miles distanct. The largest gravity system in the Dominion is that of Vancouver and adjacent municipalities, supplying a total population of 174,000. The water is derived from from Capilano River and Seymour Creek, both 9 miles distant. A very important system recently inaugurated for Victoria, B.C., has by far the longest gravity pipe line in operation in Canada. Owing to the character of the country a deviated course 38 miles in length had to be followed, although Sooke Lake, the source of supply, with an area of 1,180 acres, at an elevation of 567 feet above sea level, is only 18 miles distant in a straight line. The Esquimalt waterworks system is another important one on Vancouver Island. It supplies a portion of the city of Victoria, the Esquimalt peninsula, and other municipalities, the water being derived from the Goldstream Lakes by gravity. What will be the largest and most important gravity system in Canada is now in satisfactory course of construction for the city of Winnipeg and district. The supply is to be taken from Shoal Lake, near the Lake of the Woods, 95 miles east of the city, and at a difference of elevation of some 300 feet. The amount of water thus made available will be 80,000,000 gallons per day, and the preliminary estimates place the cost of the undertaking at over $13,000,000.

Consumption, Waste, and Meters.

The excessive water consumption in most of our Canadian cities offers a very serious problem. Again turning to statistics, we find that the average daily consumption in the Dominion is 111 gallons per capita. Individual provinces reach as high as 143 gallons per capita, while individual centres of fairly large size reach 292 gallons. It seems reasonable to think that these figures can be lowered, particularly if we compare them with the consumption in Great Britain, where it is stated to be even below 25 gallons in several cases, and the highest rate only 70 gallons per capita. That the more extensive use of meters would remedy conditions to a great extent is shown by two of our prairie provinces, where meters are more widely used than elsewhere, and where the average consumptios falls to 50 gallons and 55 gallons respectively, less than half the average for the remaining provinces. Nor would the introduction of meters mean an increased cost to the consumers. The average estimated cost of water for Canada is 10.9 cents per 1,000 gallons, the only provinces materially exceeding this being the two prairie provinces, where meter rates have already been widely adopted. The rates charged on the meter basis could be adjusted to meet different local conditions, so that the amount paid by each consumer would be practically the same as at present, but all wastes would be avoided. Many of our Canadian municipalities have both flat and meter rates in force, the consumer having the choice between the two, but as a rule the meter rates are so ridiculously high for the average consumer that there is in reality no choice. For instance, although the average estimated cost for Canada is 10.9 cents per 1,000 gallons, we find that a great many cities and towns charge 30 cents and over, with a few charging even over $1.00 per 1,000 gallons.

Our excessive consumption is not due to the liberal and beneficient use of water, but to the careless waste by a few consumers in each community. Meters will not affect the former, but will very effectively check the latter.

Cement Dust a Valuable By-Product

Recent investigations in connection with the dust resulting from the manufacture of cement have proved it to have a high potash content. A method has been devised by which the potash may be extracted from the dust and it is estimated that at least one-fourth of the potash supply necessary to satisfy the total demand in the United States may be obtained from the dust from cement mills. Potash finds extensive use in the manufacture of agricultural fertilizers and soap. Since the war the need of a new supply of potash has been severely felt. The discovery may make it possible for cement manufacturers to dispose of what has been considered a waste, at a very agreeable profit. At the same time it will reduce the discomfort attendant upon the dust arising from the manufacture of this material.

Mimico and New Toronto Joint Sewerage System

JUST beyond Toronto city limits on the west side lie the villages of Mimico and New Toronto. The latter municipality has several thriving industries and a large part of the Grand Trunk yard acreage. A sufficient and wholesome supply of water was recently considered a necessity and a system was installed under the supervision of engineer E. A. James. About this time the village of Mimico also began to be interested in water and sewerage matters and after a considerable time spent in negotiation, a joint water and sewerage system was decided upon. It meant practically that Mimico would obtain its water supply from New Toronto waterworks and that New Toronto would have its sewage taken care of by the village of Mimico.

Mr. T. Lowes, of the firm of Aird, Murray and Lowes, was chosen to design the system, and take entire charge of the construction of the works. Owing to the topography of the land, it was found impossible to gravitate the sewage to any point where sufficient head might be obtained for sewage treatment purposes; a main sewage pumping station was therefore located at the foot of Superior Avenue, Mimico, this being the lowest point in the two villages. The sewage from the above station is pumped some 3,000 feet to a piece of land situated just north of the Grand Trunk Railway main line and east of Mimico village limits.

Fig. 1—Invert.

From the sewage pumping station a main intercepting sewer was constructed along the Lake Shore Road to the western limits of New Toronto, a total length of about three miles. The main sewer is 36 inches in diameter and is constructed of vitrified segment block. The block used is of simple design, is easy to lay, and gives a maximum of strength in the finished sewer. The invert is laid ahead as shown in illustration Fig. 1, then the top ring is placed in position by means of a collapsible form. Illustration Fig. 2 shows a section of the finished sewer in a 20-foot cut.

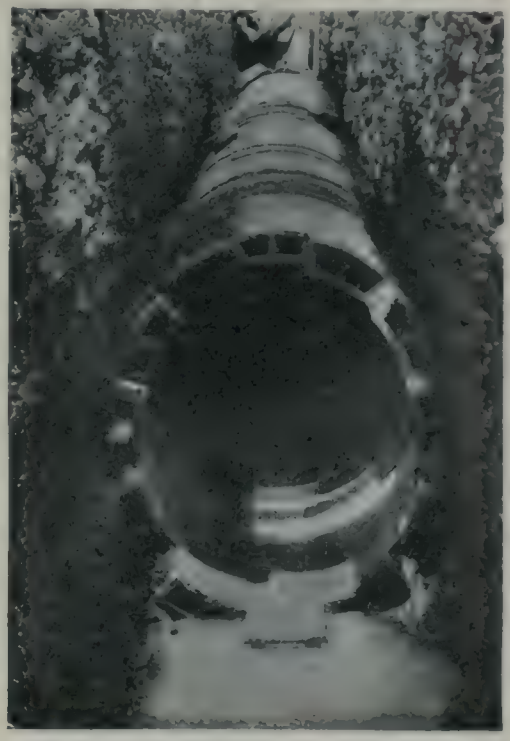

Fig. 2 Sewer complete.

The sewage treatment plant, which is constructed upon the most up-to-date principles, consists of:

(a) Primary sedimentation tanks.
(b) Sprinkling filters.
(c) Chlorine disinfecting plant.
(d) Humus tanks.

(a) The duplicate sedimentation tanks are of the two-storey type, the dimensions being 30 feet in length, 15 feet in breadth, and total depth of 28 feet. These are so designed that the raw sewage flows over the longitudinal section of the tank thus giving a minimum velocity and maximum sedimentation. The sludge compartment or lower section is designed to hold six months' storage of sludge. During dry weather, sludge is removed to a drying bed; after a few days it can be disposed of and used for filling any low-lying section of land in any locality as it has no objectionable features. The period of retention in the tanks for normal dry weather flow is two hours.

(b) The sprinkling filters consist of two beds each 100 feet in length by 25 feet in breadth and six feet in average depth. The travelling distributors used for

spraying the tank effluent over the surface of the filters were supplied by Adams' Hydraulics, York, Eng. These machines operate automatically under a 3-foot head of water.

(c) The chlorine house or disinfecting plant consists of a brick building 20 feet by 12 feet, together with concrete hoppers and head tank which contain the chlorine solution.

(d) After the sewage effluent has been sterilized, it then passes to a final settling tank, generally termed a humus tank. This is also built on the two-storey principle. The whole of the works are under cover and present a very neat appearance.

The effluent is conveyed direct to the lake by means of a 24-inch vitrified pipe line.

The contracts were let in October of last year for the construction of the above works—the laying of sewers and water mains to Mr. R. B. Stewart, of Whitby, Ont., and the sewage treatment plant to Mr. F. F. Fry, of Toronto. All vitrified pipes and specials were furnished by the Ontario Sewer Pipe Company, Limited.

Some Activated Sludge Problems

By R O. Wynne-Roberts*

THERE can now be no doubt in the minds of engineers and sanitarians generally concerning the possibility and adaptability of the activated sludge process of sewage treatment. In the United States the process is being applied to many kinds of sewage and according to information obtained by the Engineering Record and quoted in the Contract Record of August 9th, the waste from packing houses can be dealt with satisfactorily.

Many minds are at work evolving solutions for various difficulties, which would seem to indicate that the activation of sewage on a practical scale is not as simple as might appear on paper. Yet what new process has been introduced that was found to be without initial difficulties to surmount? Sewage treatment has always been brimful of difficulties, but to-day, thanks to the researches of scientists, the knowledge that certain conditions must be met enables engineers to secure a greater measure of success than has hitherto been possible.

Installation at Worcester

Owing to the unprecedented activity in Britain to prosecute the stupendous war, it is not to be expected that much development in sewage treatment can take place at present. The Government has virtually stopped all new municipal works which are not urgently needed in connection with the production of munitions. Nevertheless, progress is made with the activated sludge process. The city of Worcester has adopted this method of sewage treatment for about 800,000 Imperial gallons per day. The existing tanks were adapted at small cost and the results are reported to be satisfactory. The process has been applied in one of two sets of tanks which vary in depth from 16 feet at one end, to 17 feet at the other. No. 1 tank is 80 feet long and 8 feet wide. Nos. 2 and 3 tanks consist of two channels of the same length and width as above. No. 1 tank has seven baffle walls and a ridge and furrow bottom fitted with diffusers, and as the sewage is clarified it flows over a weir into No. 2 tank and afterwards into No. 3 tank, which has no diffusers in the last 30 feet of the return channel. The sewage is circulated up one channel and down the other by the arrangement of the diffusers and baffles causing an air lift action. The effluent from No. 3 tank flows over a weir into a channel and is then conveyed to two small inverted conical tanks similar to the well-known Dortmund shaped tanks. The sludge settles in these tanks and is raised by air lifts into a conduit connected to the sewage inlet, where it is effectively mixed with the incoming sewage and passes again into the aeration tanks. The quantity of air used is stated to be less than one cubic foot per cubic foot of sewage per hour, which produces an excellent effluent with three hours' aeration. The quantity of sewage at Worcester is approximately 40 gallons per head per day. Messrs. Jones and Attwood, the patentees of the process, guaranteed that the effluent should not contain more than 40 p.p.m. of suspended matter, and that it should not be capable of putrefaction. These conditions are reported to be complied with. It is interesting to note that Messrs. Jones and Attwood, in this case, agreed to allow payment to be deferred for one year and settlement to be subject to the process being satisfactory. That is, "no cure, no pay." The quantity of air used at Milwaukee during the months of June to November, 1915, inclusive, averaged 2.25 cubic feet per imperial gallon with an aeration period of about 3½ hours. At Worcester the air consumption is stated to be 0.50 cubic feet per imperial gallon with an aeration period of 3 hours.

Other interesting installations in England are at Stamford, where the sewage contains waste from large breweries and a slaughter house; at a consumptive hospital with a population of 500 where the sewage contains large quantities of disinfectants; and at a government munition factory employing about 2,000 persons. The original tank at Davyhulme, Worchester, where the activated sludge process was first evolved, is being remodelled. The sewage at this place contains a large proportion of inhibitive chemical trade wastes.

The process at Worcester, Stamford and Davyhulme is continuous, in the others fill and draw, and the tanks vary from 3 to 17 feet in depth.

The Sheffield Sewage Disposal Department, under the direction of Mr. John Haworth, F.C.S., the manager and chemist, has carried out some interesting experiments. Sheffield sewage contains large volumes of trade wastes containing iron and other metallic salts, hydroxides and mineral acids, which render the problem of treatment a difficult one. In fact the inhibitory action of these wastes has once destroyed the efficiency of the sludge for a time. It is therefore necessary to watch for the intermittent discharges of acid waste and to neutralize the liquor so as to make it amenable to purification by this process. Two experimental tanks are fitted with diffusers and the sludge is activated by the usual method but the sewage is previously settled. The results obtained are stated to be good.

In this article reference will be made to two problems which occupy a great part of the attention and

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consideration of experimenters in Britain and America, namely, the tank, and the distribution and diffusion of the air supply.

Design of Tank

The plan and section of the tank depends largely upon local conditions. There do not appear to be strong reasons for building tanks of any particular shape. The primary requirements in the case of aerating tanks are that there shall be no eddies or dead places where sludge can settle and decompose; that the sewage shall be uniformly aerated and afterwards efficiently "settled." The patentees make use of the expansion of the volume of water due to the presence of air, to promote circulation through the tanks. Others provide a small fall between the inlet and outlet of the tanks. Tanks are often divided into channels by partitions and baffles so as to keep the air and sewage in intimate contact for as long a period as is practicable. It will have been observed in the description of the Armour experimental tank at Chicago, that the partitions are horizontal and cause the flow of sewage to take a zig-zag course. At Worcester and Milwaukee the partitions are vertical, the latter taking roughly the form of a broken horizontal letter U placed in an enclosing circle, but in the former the partitions divide the rectangular tanks into go and return channels. At Baltimore a large two-storey tank has been adapted and the flow made to take the reverse direction to that which it would ordinarily have done. The air-lift action is utilized to cause the sewage to overflow through the top central opening of the detritus chamber, the sludge settles in the sedimentation section and returns by gravity to the detritus chamber, while the clarified effluent passes out at the perimeter into outside channels.

The question of depth of the tank is governed by a consideration of local conditions, cost, extra power to force the air, and so on. On the other hand, the deeper the tank the smaller is the initial bubble of air; the contact between the air and the sewage is increased, and the absorption of the oxygen is greater. Tanks, however, are now in operation where the depths range from 3 feet to about 30 feet, so that the best and most economical vertical dimension has not yet been standardized. Air blowers are efficient up to a total maximum pressure of about 10 pounds, rotary air compressors and multi-stage blowers will furnish air up to about 20 pounds pressure. A positive blower requires about 5 h.p. at the shaft for every 1,000 cubic feet of free air at 1 lb. pressure. The heat due to compression by blowers is small. Mr. Harding expresses the opinion that when the depth of sewage is 20 to 25 feet an ordinary reciprocating air-compressor is necessary.

The bottoms of the tanks are constructed in different ways. The ridge and furrow section, with diffusers fixed in the furrows, has been adopted in many places, while at Armour's experimental plant a saw-tooth bottom was abandoned as unnecessary. The aerator tank at Brooklyn, N. Y., has a flat bottom. One of the Sheffield experimental tanks has a semi-circular bottom for reasons which will be given later on. The object aimed at in all cases is to secure the maximum mixing and aerating effects of the air.

Distribution of Air

The distribution of the air and its diffusion have afforded the designers of tanks and distributors a scope for ingenuity. The perforated pipe distributor has been tried in a number of installations and has been found to do good work, so long as the apertures are clean, but when the air is shut off the sludge enters the orifices and gradually chokes them. At Brooklyn, N. Y., Mr. Hammond placed the perforated pipe distributors on a bed of broken stone and covered the pipes with another bed and this has been found to answer for 2½ years without cleaning, with a sewage depth of 22 feet. At Baltimore the pipes are hinged, like the ribs of an umbrella, and when necessary can be hoisted out of the tank and cleaned or repaired. At Sheffield Mr. Haworth placed perforated pipes beneath about two feet of clean clinker broken to ¾ in. gauge, and this has been in operation for over nine months, giving good results.

Mr. Haworth also adopted another method. A central cylinder is placed vertically in a tank, and a shaft having propeller blades or Archimedean screw attached thereto is inserted. The top of the cylinder is below the top-water level and the other end a short distance above the semi-circular floor of the tank. Some of the propeller blades operate within the cylinder and the others are below it and near the tank floor. A small air pipe is inserted at the top edge of the cylinder with the inlet standing above the water level. When the propellers are worked at about 15 revolutions per minute the sewage is driven downwards, and air is sucked in through the small pipes. The mixture of sewage and air is deflected upwards by the semi-circular floor and it rises in the annular space between the tank walls and the central cylinder, only to be again drawn in and circulated by the propellers. The aeration is continuous and the agitation is good.

Diffusers

The use of porous plates or disc diffusers has been referred to so frequently in these columns that the advantages claimed for it are doubtless well known. The symposium of opinion expressed by several American experimenters on the use of diffusers and pipe distributors and published in the Engineering News of July 20th, 1916, is most interesting. The vapour of oil from certain air-blowers gradually clogs the under surfaces of diffuser places, but where there is no oil vapour this trouble is not experienced. Dust must be eliminated from the incoming air or it will collect on the plates. This can be done by the use of filters or cheese cloth. The use of washers tends to humidify the air and this increases the resistance of the diffusers. On the other hand, hair and heavy particles of sludge tend to choke the upper surfaces of the plates and this interferes with the uniform distribution of the air, which is essential for efficiency of treatment. Mr. George T. Hammond, of Brooklyn, N. Y., expresses his opinion that "the ideal diffuser should give an easily controlled flow and volume of air, equally diffused to all portions of the tank, with the bubble of the 'critical' size formed at the point of entrance. It should not tend to become clogged, or at least should not tend to unequal clogging. It should be readily cleaned in place without emptying the tank, or should be easily removable for replacement and for cleaning in case of clogging. It should show the minimum deterioration in service, and its cost should be reasonable."

The measurement of air can be done by installing a Venturi meter, an air meter, or an orifice and differential monometer. Mr. Langdon Pearse, of Chicago, employed a steel storage tank 5 feet high and 5 feet in diameter to reduce the pulsating effect due to the reciprocating motion of the air compressor. The

writer installed an old steel gasoline barrel for the same purpose and found it to act efficiently.

The control of the air pressure and supply when existing tanks are utilized for the activation of sludge is a subject of importance, because of the difference in level of the tank floors. Even when they are level it is necessary to control the air supply so as to obtain uniformity of aeration and agitation.

Lessons for Canada

In conclusion it may well be stated that sanitarians in Canada appreciate the value of the work done in the development of sewage treatment in other countries. Science is international and cannot be limited to or monopolized by any country. The close study made of this important subject by scientists outside the Dominion warrants a keen observation on our part so as to secure what information and knowledge is available by the research work of those who devote their talents and time in the evolution of the process. Yet Canadian engineers, chemists and others should be given an opportunity of showing what can be done at home to promote the development of what is of great importance to Canadian cities and towns. According to the report issued by the Commission of Conservation there are 180 municipalities in Canada discharging raw sewage into the inland waterways. The municipalities are urged by the provincial governments to remedy this evil, but at present very little is done to show them what can be done to improve the condition at the minimum of cost and maximum of efficiency. The premier cities and the governments should lead by having model installations, and have careful investigations made at home to study our own problems and how best to solve them. A perambulation of other sewage work does not always solve our difficulty. The activated sludge process is certainly beyond the initial experimental stage of development, but there is nevertheless most valuable information to be secured by personally observing the process from day to day.

Haileybury Waterworks Plant

By Thomas Lemon*

The town of Haileybury is situated on the west shore of Lake Temiskaming, from which it receives its water supply. When the waterworks system was first installed, samples of the lake water were analyzed and reported good.

Later on, however, the water showed contamination, and it became necessary to install a chlorinating system which seemed to relieve the trouble. Later, however, it became advisable to install a filtration plant.

The filter system now in use was installed in the winter of 1912-1913, and was erected and built by the Bell Filtration Company, of Raventhorpe, England.

These filters are situated about 100 feet from the pumping station. The water is pumped direct into filters from electric-driven centrifugal pumps of 750 gallons per minute. Pumps are duplicated. The water from the pump passes through a Venturi tube. At entrance to filters are erected two plunger style pumps, driven by water turbines. The water passing into the filters operates these pumps, which are used to discharge the chemical into the water for purification purposes. The chemical is dissolved in sheet iron tanks of 500 gallons capacity. There are two of these tanks, which are used alternately. The chemical flows from these tanks to an equalizing tank, which is controlled by a valve and float. This tank supplies the receptacle, from which the pumps discharge it into the unfiltered water.

Attached to the Venturi tube is a chamber for feeding rock lime. The lime is first stacked and then mixed into a liquid, which is poured into lime chamber at top through a hinged cover. The water passes into lime chamber at the bottom, and the lime is carried into the unfiltered water by means of a down pipe from the top of lime chamber. The quantity of lime water being fed is registered by means of a manometer, which is operated from a small Venturi tube in the down pipe. After the water has been treated with these chemicals it passes into the filter tanks, of which there are five, 8 feet in diameter by 6 feet in depth. These are filled to about three-fourths their capacity with sand. At the bottom of the sand are a number of strainers, which cover the bottom of the tank. These strainers are 8 inches in depth and are 6 inches in diameter on top and taper to 1 inch at bottom, which are screwed into cast iron branches that lead to the main outlet of filter tank. These strainers are filled with small white quartz stones. The water, in passing through the sand and strainers, is relieved of all impurities and color.

The sand and strainers are washed every day. This is accomplished by reversing the water, shutting off the unfiltered water from entering the filter, and allowing the filtered water to pass up through the strainers and sand. Each filter tank is washed separately. The sand is moved by agitators inside the tanks operated from a line shaft running the full length of the plant on top of the filter tanks and attached to each agitator by a crown gear and pinion. By this operation every part of the sand is moved during the washing process.

After the water leaves the filters it goes into the water mains, and the surplus water into the reservoir, which is concrete, of 215,000 gallons capacity.

The cost of labor and chemical, under ordinary conditions in operation of filtration plant, amounts to $2.00 per day.

There has been every satisfaction with the plant since it has been in operation.

* Waterworks Superintendent, Haileybury.

A Very Complete Catalogue

The Canadian Brass Company, Limited, of Galt, Ont., have just issued a new catalogue covering brass goods for plumbers, gas companies and waterworks. The catalogue consists of about 150 pages containing close to 300 half-tone illustrations of the products made by this company. The catalogue is known as catalogue "C" and "E," the "C" section representing the products sold to waterworks companies, and the "E" section representing the lines made and sold to plumbers and gas companies throughout the Dominion. The waterworks section is very complete. It shows a line of sundries, such as melting pots, lead joint runners, etc., as used by the corporation; also a complete line of corporation brass goods. The Canadian Brass Company, Limited, have a splendid reputation throughout this country for turning out brass goods of the highest quality. The company have made excellent progress. This is not surprising in view of the fact that the members of the company are successful business men. The president is Mr. Geo. A. Dobbie, the vice-president, Mr. F. Stewart Scott, M.P., and the secretary and general manager, Mr. Geo. E. Fisher.

Typical Sewer Work in Toronto

Trunk Lines of Special Interest—Brick favored for the most part—Storm Sewers of Concrete with Brick Lined Invert

THIS article describes briefly a few of the characteristic features of the sewerage system of a large city. In the main the description applies to the city of Toronto.

The city of Toronto has a total of 480 miles of sewers of all kinds. Of this amount, the larger portion, 433 miles, are small sewers of a local nature, including house installations and adjuncts. The remaining 47 miles consist of sewers of a larger type, for sanitary and storm purposes, varying in size from 2 feet in diameter to 9½ feet in diameter.

A passing word is sufficient to indicate the nature of Toronto's local or purely domestic sewers. Sewers under 24 inches in diameter are employed for carrying house sewage and for installations of an entirely local variety. All sewers of this type are constructed of standard tile pipe. The reasons for making use of tile for smaller sewers are fairly obvious—cheapness, effectiveness for the purpose, and ease of handling and setting, with opportunity for easily replacing or enlarging. At the present time, no sewers are laid which are less than 12 inches in diameter. Pipes as small as 9 inches were installed a few years ago, but the smallness involved disadvantages that have favored the substitution of larger sizes. It was found that 9-in.

Fig. 1—A portion of the Keele St. sewer during construction—Carried on trestle work, since filled in.

pipes were extremely easily clogged and went into disrepair very readily due to indiscriminate choking of street inlets and manholes. A 12-in. minimum size avoids these drawbacks to a much larger extent and at the same time allows the pipe to be flushed and inspected quite easily. A point worthy of note is that all sewers in Toronto above 12 inches in diameter are coated with a 3-inch covering of concrete, enveloping the entire pipe, not merely its top. To ensure contractors making excavations of sufficient width to accommodate this extra size, a wooden collar projecting three feet all around is fitted over all pipes to be thus coated.

Metallic Pipes

A word or two is sufficient to indicate the extent of the use of metallic pipe in sewer installations in Toronto. Pipes of this kind are not extensively employed. Their use is practically limited to locations on heavy grades, or when suspended on bridges, or when they act as syphons. Cast iron is in general the material used, although steel plate has been employed in one or two instances. Careful coating of the metal

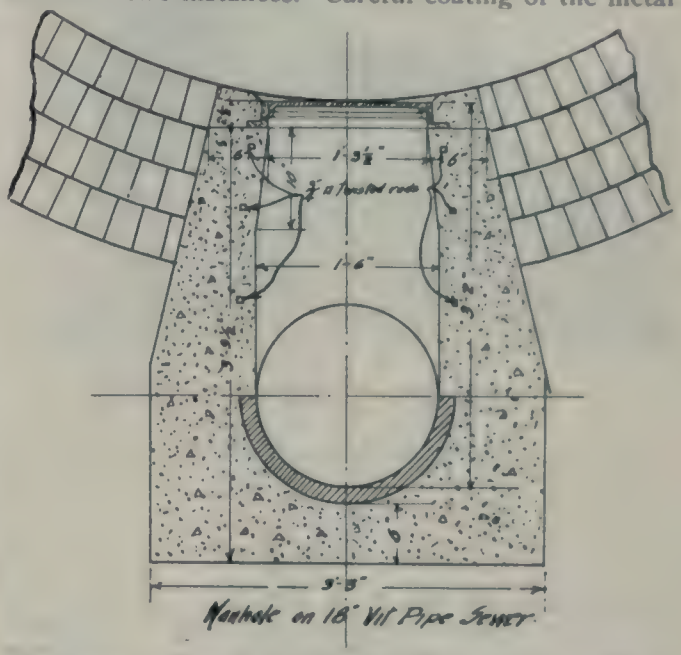


Fig. 2—Section of Keele St. sewer, showing small sanitary sewer beneath main sewer pipe.

is necessary to avoid corrosion or chemical action.

Factory moulded concrete pipes are used in a few Toronto installations of medium and small capacities. The cheapness is the chief advantage and their purpose is almost exclusively limited to storm water work, since concrete is unable to withstand the corroding effects of sanitary sewage.

The above describes in a more or less general manner the materials forming the smaller sewers of Toronto; that is, those of a local or domestic nature. The larger sewers, in which class are considered all those over 2 feet in diameter, are almost invariably of brick or concrete. The larger sewers fall into two classes according to the purpose for which they are intended—sanitary sewers carry the debris and effluent that compose the city's sewage; storm sewers are intended to provide for the carrying of storm water. There are a few combination sewers which, until sewage and storm water are separated, are called upon to act as both storm and sanitary sewers.

In general, sanitary sewers are built of brick, while for storm sewers, concrete construction is considered as efficient as any other and cheaper. Concrete is affected to a considerable extent by the action of the gases and liquids present in sewage, so that as a material for sanitary sewers, it is not recommended. Brick, on the other hand, is capable of withstanding the effects of deteriorating gases, and on this account is suited for sewers that carry sewage. The cheapness of concrete is an important factor.

No brick sewers are built in Toronto with less than

two rings of brick. The number of rings is increased with the size of the pipe and also with an increase in the soil load on the sewer. For example, if for a given sewer, at 25 feet depth, two rings are used, then at 35 feet below ground surface, three rings will be employed. In the larger concrete pipes the inverts are usually lined with brick. This increases the wearing

Fig. 3—Garrison Creek Sewer, showing weir. Main storm sewer in foreground. View looking North.

qualities on the important parts and prevents erosion from the sediment and silt that are invariably carried down with storm water.

Segment Block Sewers

Sanitary sewers built of segmental tile blocks have been installed in a few instances for sanitary purposes, but they are as yet in a more or less experimental stage. In open cut work where the blocks may be lowered into place, sewers of this nature are admirable, but in tunnel excavations, where the segments at the top have to be lifted and set by hand,

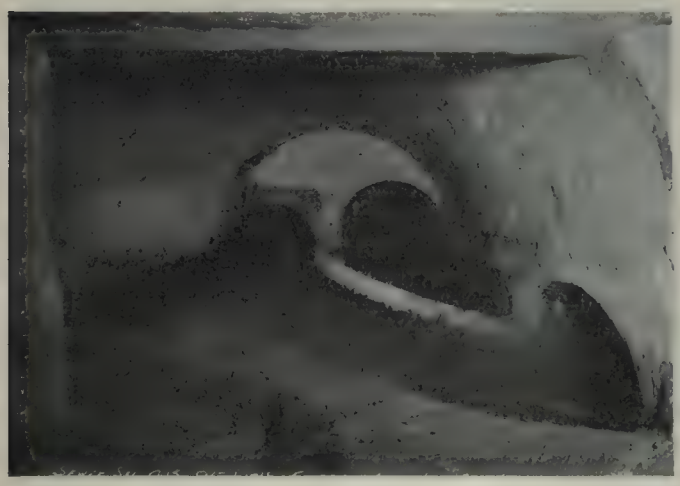


Fig. 4—Same as Fig. 3, looking South.

their weight constitutes a drawback. It has been found that sewers of this design have a larger capacity than other pipes of a similar size, since the velocity is increased on account of the extreme smoothness of the inner surface. Examination of block sewers that have been in use shows a glassiness of the interior not found in sewers of brick or other material. As regards life and durability, the introduction of segment blocks is so recent that accurate and definite information in this connection is lacking.

The nature of the sub-soil in which a sewer is to be laid governs very often the nature of the material to be employed, outside of the above considerations. If the undergrade is of a flowing or semi-liquid consistency, a quick setting material must be used. An example of this was the Argyll Street sewer, Toronto, where the ground was a plastic clay of such a nature that it flowed in all around the sewer. This made necessary a pipe that took its shape readily and quickly. Brick was employed in this instance. Concrete in such a case, on account of requiring a considerable time to set, might have crushed under the flow of soil.

Trunk sewers in Toronto are usually constructed with a circular cross-section. Egg-shaped pipes are sometimes used in sizes ranging up to 4 ft. by 6 ft. Concrete storm sewers are frequently culvert-shaped, although circular ones are also made. As before stated, the invert of these pipes is usually lined with one ring of brick.

Life of Sewers

The life of the various types of pipe is a matter of more or less indeterminate knowledge. Brick sewers are generally conceded to possess the best lasting qualities. A life of thirty years is usually assumed, although with good construction, this will be indefinitely prolonged. The life of concrete is even more an unknown quantity, since its introduction is so recent that there is no basis of fact in this regard. As to segment block, the most recent development in sewer work, no definite information can, from experience, be given concerning the life qualities.

The nature of the soil imposes local difficulties of construction that require special means of overcoming.

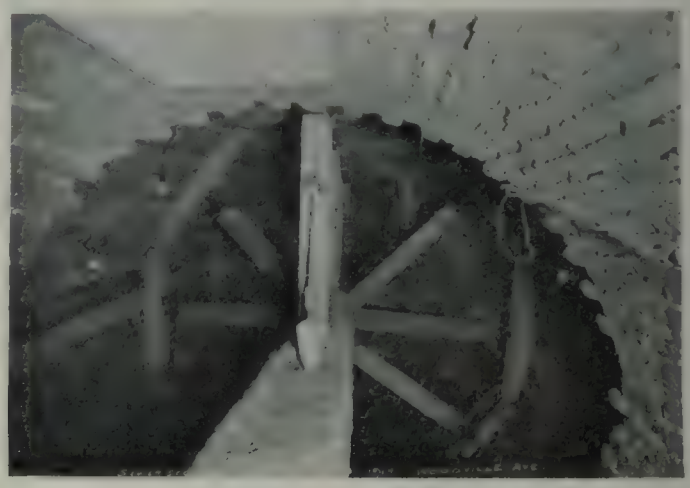


Fig. 5—Needle beam construction of sheeting.

In quicksand or soft, flowing soil, compressed air is the accepted method by which excavation and pipe setting is accomplished. In Toronto, the sections between shafts are from 65 to 70 feet long with air locks at the ends about 10 or 12 feet in length. In soft bottom a trough or open box of timber is set to grade on the soil and the bottom covered with a layer of concrete levelled to grade. The pipe is set on top and the space all around filled in with concrete. If the bottom is too soft to sustain this treatment, stake piles are driven every few feet with sills placed on top, the trough being then rested on these sills.

In running sand, a special canvas covering is used by Toronto engineers to enclose the joints in this

pipe, to keep out the sand. The cloth is attached to one pipe before laying, by tightening a wire passed through a hem on one edge of the material. After making the joint the other edge is tightened by twisting a similar wire in the opposite hem.

Keele Street Sewer

The accompanying illustrations show typical examples of Toronto's sewer installations under construction. Fig. 1 is a view taken during the building of the Keele Street sewer, which forms one section of the Toronto system. A cross-sectional diagram is shown in Fig. 2. The major portion of the sanitary sewer is of brick with a small section of hollow tile segment blocks installed, as an experiment. The main part of the system, carrying both sanitary sewage and

Fig. 6—Egg shaped brick sewer. Concrete storm sewer to left with separating weir.

rain overflow, is of brick, circular in section, 9 feet in diameter, four rings thick. This pipe is the only one ordinarily in use where only sewage or light storm water is carried. In heavy storms, where the overflow taxes the capacity of this sewer, separation of sanitary sewage and rain water is effected by means of a weir, the sewage continuing through the sanitary sewers to the disposal works, while the water which passes over the weir is directed to a large concrete stand-by or storage tank from which it is carried to the lake by a concrete storm sewer. Floating arms in the stand-by tank hold back any scum or solid debris as the water level drops, and, after a storm is over, manholes in the interior are opened, allowing this material to flow into an 18-in. vitrified pipe sewer built below the main pipe, Fig. 2, to the disposal works. This sewer is at some places carried on a trestle and at others is as much as 75 feet below ground level, compressed air being required in the deep excavations, owing to the soft nature of the subgrade.

Garrison Creek System

Another typical installation of a larger sewer is the Garrison Creek system, having a total length of about 8,500 feet, illustrated in Figs. 3 and 4. This sewer at its upper end is also a combination storm and sanitary sewer, of brick construction. Separation is also carried out by means of weirs, and the storm water is carried away by an overflow sewer constructed of concrete. The greater part of this overflow sewer is culvert-shaped with a brick-lined invert. The discharge takes place into the lake.

In Fig. 5 a method of sheeting is illustrated. This particular method is called the "needle-beam" system and involves a central beam bearing radiating spokes which support the sheeting.

Water System of Red Deer, Alta.

By A. T. Stephenson*

The water of the Red Deer River is used for city purposes, and the method of treatment is unique. The water is taken from the centre of the river by means of an 18-inch gravity pipe, which conducts it into two circular wells with a diameter of 16 feet and a depth of 25 feet each. These wells are situated close to the river bank. Inside of each well is a circular screen, two feet thick, and with an outside diameter of 12 feet. This leaves a space of two feet between the screen and the concrete wall of the well, and the water from the river is conveyed into this outer chamber. The water then passes through the screen of gravel, sand, and charcoal, which is held in place by a ¼-inch steel wire mesh on each side of the screen, into the middle chamber, from whence it is pumped into the mains for distribution. The gravity pipe forms a Y just before it reaches the wells, one branch entering each well, and in each branch valves are installed, so that the water can be shut off each well to enable the screens to be cleaned from time to time. By means of a float valve a direct opening can be obtained direct from the river to the inner chamber, so that an ample supply can be obtained in case of serious fire or other emergency without using the screen. From the pumping plant duplicate mains are laid to the main point of distribution, so that either or both may be used if required.

This system results in considerable silt being taken from the water and all rough rubbish such as in the river every year in flood time, but considerable silt is left in the water which is pumped through the mains. This can only be remedied by the use of mechanical filters or settling basins of large capacity, and Red Deer is hardly large enough to go in for such an expensive system at present.

The city has an agreement with the Western General Electric Company, Ltd., which owns the electric light plant, for operation of the system. The city pays the company $50.00 per hydrant per year and 60 per cent. of the gross water rates collected. The city collects the rates and turns over to the company its share of the revenues each quarter. This, so far, has worked out to the advantage of both the city and the company.

The pumps—duplicate ones, made by Snow Company, of Buffalo, of 1,000,000 gallons daily capacity each—are installed in the power-house of the company, and the distribution system is about seven miles, mostly cast iron pipe. There are 305 consumers at present.

A septic tank and filtration system are at present under construction.

* Utilities Commissioner, Red Deer

Water Supply of Saskatoon, Sask.

Sedimentation Supplemented by Roberts Filters—Electrically Operated Pumps Backed by Steam Reserve—Consumption 45.6 Gals. Per Capita Per Day

By G. D. Archibald*

THE city of Saskatoon derives its water supply from the west side of the South Saskatchewan River, at a point approximately one mile above the Canadian Northern Railway bridge, and about the same distance above the outlet of the nearest sanitary sewer. The water is conveyed to an intake well by gravity through a 36-inch C.I. pipe, the inlet of which is located about 100 feet from the shore line, in about 10 feet of water when constructed, the elevation of the invert being 1,522.5, while the low water elevation is 1,531.

The intake well is octagon in shape, constructed of reinforced concrete, and located on the top of the river bank the elevation of the bottom being 1,517 and the top 1,564. The well is 20 feet smallest diameter. A cast iron penstock has been constructed over the intake at the well, this being operated by a capstan from the top. An electric hoist, with a one-third cubic yard capacity clam shell bucket attached, which is used for the removal of sand, is fixed on top of the well.

The raw water pump well is located about 175 feet west of the intake well. The elevation of the floor in this well is 1,542.2, pumps being set up on pedestals about three feet higher. It is 22 feet 8 inches square inside, constructed of concrete up to elevation 1,565 (which is the approximate ground level), and housed in with brick walls; steel trusses carry the roof. Foundations are placed in this well for four centrifugal pumps ,and suctions are laid in the tunnel between the intake well and the raw water well for these pumps. At the present time, however, only two are installed,

Motor-driven domestic pumps, Saskatoon.

which have a capacity of two million gallons per day each, against a head of 40 feet. These pumps are De-Laval centrifugals, direct connected to 25 h.p. motors, running at a speed of 1,760 r.p.m. The additional installation provided for is two centrifugal pumps, with a capacity of 4,000,000 gallons per day each, against a head of 40 feet.

*City Engineer, Saskatoon.

During the period the river is free from ice the raw water is pumped to a sedimentation basin, located a short distance north of the pump well. The size of the basin is 335 feet long and 105 feet wide, greatest length and width, with a maximum depth of 10 feet, the elevation of the water being 1,566.25. The basin is constructed of timber, backed by earth, and has a capacity of about one and a half million gallons. It is divided in two parts by a concrete wall. The water enters the basin at the north end, through two 16-

Pumping station and filtration plant, Saskatoon.

inch outlets ,and flows southerly towards the filtration plant. As it passes through the division wall a coagulant of sulphate of alumina is added to aid the precipitation of the silt. This chemical is added in proportion to the amount of silt the water is carrying and quantity passing through. After leaving the sedimentation basin the water flows by gravity through a 30-inch C.I. pipe to the filtration plant, a distance of about 50 feet. When the ice covers the river the raw water is pumped direct to the filters, as no sedimentation is required.

The filter plant has been constructed on the design of the Roberts Filter Company, of Philadelphia and consists of six sand filters, controlled by hydraulic valves, with a clear water well located directly underneath, to which the water passes through automatic control valves. The capacity of the filtration plant under the worst conditions is about four million gallons daily. The filters are distinct units. Any one may be operated by itself or in series with any other.

The machinery for cleansing the filters is located on the machinery floor, in the same building, and is all operated by electricity. On the second floor in this building are located the mixing tanks for the chemicals used for coagulation purposes, these being controlled by calibrated orifices, so that the amount of chemicals added will be in accordance with the quantity of water and silt, as before stated. Also in this building is located a chemical laboratory, in which the water from

each filter and also the raw and tap water are tested daily.

From the clear well the water flows by gravity to suction wells in the pump house. These wells are constructed of steel boiler plate.

The machinery in the pumping station consists of two Domestic pumps, capable of discharging 1,600,000 gallons daily, at a pressure of 65 pounds to the square inch. These pumps are direct connected to 100 h.p. motors, and turn approximately 1,800 r.p.m. Two

Interior filtration plant, Saskatoon.

boosters of 50 h. p. each, capable of discharging 1,800,000 gallons when connected to either of the domestic pumps against a pressure of 110 pounds per square inch. Provision has also been made for the installation of two additional pumps of 4,000,000 gallons capacity each. All pumps are controlled from a gallery, raised about 10 feet from the machinery floor, on which is also located the registering device for the Venturi meter. The elevation of the floor in the pump room is 1,565.

Previous to the installation of the electric equipment the water was pumped to the city mains by steam machinery, consisting of two vertical deep well pumps with a capacity of 600,000 gallons per day each. These pumps raised the water to the sedimentation basin and, after passing through same, it was returned to the pump wells, in which it was taken by a high-duty Inglis cross-compound pump, which was capable of delivering one million gallons against 85 pounds pressure when running 48 r.p.m. and one compound Canada Foundry duplex, with a capacity of 900,000 gallons per day, at a pressure of 85 pounds to the square inch. The boiler installation consists of two Robb Armstrong water tube boilers, 250 h.p. each, with a working pressure of 150 pounds.

Up to the beginnning of 1915 the pumping station and filtration plant were run under different departments, the City Engineer's department having control of the filtration plant and the city electrical engineer having charge of the pumping plant. This arrangement was changed on the above date, and now the whole of the water supply comes under the direct supervision of the City Engineer. The two plants have been connected with a passageway, making it possible to operate both plants under one chief engineer.

The intake for the steam deep well pumps is separate from that of the electrically driven pumps, so that, should anything happen to the electric end, the water supply can be maintained with the steam pumps, irrespective of the connections for the electrical equipment.

The different machines and connections at the pump house are connected with bypasses in such a manner that almost any conceivable arrangement may be operated—that is, the raw water may be handled direct to the city mains, or may pass through any one of the units described above. The domestic pressure is maintained at the pumping station as nearly as possible at 65 pounds to the square inch. This gives a domestic supply in the highest building in the city at present of not less than 25 pounds to the square inch, while in the business section, owing to the large mains, it is possible to maintain a working pressure of about 55 pounds to the square inch.

Two standpipes, located about two miles apart, in different parts of the city, act as cushions and in a small way as reservoirs. In case of fire the standpipes are closed by electric operated valves from the pumping station, and the water is then passed through the booster pumps, which maintain a fire pressure of 110 pounds during the period of the fire.

All water leaving the pumping station passes through a Venturi meter, except that from the steam pumps; these will shortly be connected so that the discharge will pass through the meter. As all connections throughout the city are metered, a very close check on the water can be kept.

In 1914 an additional sedimentation basin was started, but was not completed then, owing to financial conditions caused by the outbreak of the war in Europe. This basin is almost the same size as the

Steam auxiliary pumps, Saskatoon.

existing one, and is now being completed. It is constructed entirely of reinforced concrete. When completed it will be possible to reduce the amount of coagulant used by a very appreciable amount owing to the increased time for sedimentation.

The total output from the pumping station for the year 1915 amounted to 492,000,000 imperial gallons, giving a consumption per capita of 45.6 imperial gallons per day. The amount of coagulant used was 70,000 pounds. This latter figure will, however, be greatly exceeded this year, owing to the increased turbidity of the water in the river.

The pumping and filtration operating staff is as follows: One chief engineer, one assistant engineer, three shift engineers, four helpers.

Water Filtration Plant at The Pas, Man.

By G. A. Williams*

THE PAS water filtration plant is located on the bank of the Saskatchewan River, in the rear of the electric and pumping station. It was constructed under the supervision of Messrs. Murphy & Underwood, consulting engineers, Saskatoon, Sask., and is comprised of subsidence basin and filter beds.

The subsidence basin consists of two adjoining concrete covered basins having a capacity of 93,750 imperial gallons each, and a rate of filtration of 75,000 imperial gallons at three hours' subsidence. The structure is covered with two feet of earth, and sides are banked to the natural slope as a protection from extreme temperatures.

The floor of each basin is graded to the centre, at which points are located blow-off valves, arranged on sewer pipe line, which is used for draining off the water and washing out the basins.

The raw water from the pumps enters basin No. 1 through a butterfly valve, which closes at highest level, the basin also being provided with an overflow to prevent flooding. At the butterfly valve a solution of sulphate of aluminium is applied the strength of which is governed by the amount of sediment in the water.

Upon leaving the inlet a wooden stilling wall or partition is encountered, which consists of two-inch planking, through which two-inch holes have been cut every twelve inches each way. This wall, with its holes, has a tendency to distribute the current of water over the entire basin.

At the further or opposite end of the basin a similar wall is provided, and, following this, a series of baffle walls, which lead the water in a zig-zag fashion across the end of the basin and through an opening in the centre dividing wall into basin No. 2, where similar stilling walls are encountered, and at the front or filtration building end, is led into the filter basins through eight-inch pipe lines, the inlets of which are 8.33 feet from the floor level. The pipe lines are controlled by individual valves, the operation of each filter basin being independent of the other.

The filter basins, two in number, are approximately 10 by 18 feet, with a depth of 8.5 feet.

Upon the floor of these basins are laid the water manifolds, which consist of oval-shaped cast iron piping, to which are attached numerous branch pipes, and to which are affixed small brass strainers. Concrete is then laid, covering the piping and manifolds, but leaving the strainers exposed slightly above the floor.

Immediately above the strainers are laid the air manifolds which consist of four-inch piping the entire length of the basins to which are also attached small branch pipes, which are drilled with numerous small holes of about 1/16 inch diameter on the upper sides of the pipe.

The basins are filled with nine inches of coarse, sharp gravel and then with 2½ feet of good, sharp sand.

Wash troughs are also provided, which are suspended about one foot above the sand, which are attached to the sewer through suitable controlling valves.

The aforementioned water and air manifolds extend through the concrete walls of the basins into the pipe gallery, where are attached the valves for the control of the various operations.

The air manifolds are connected to a main pipe line leading from a large capacity blower located on the upper floor of the building.

To the water manifolds are attached crosses. one branch of which leads to the sewer, another to the wash pump mains, and the third to the rate controllers, which discharge into the clear water well, which is located immediately below the filter basins and pipe gallery. This well is about 12 feet deep, and has a capacity of 37,000 imperial gallons. From this well the filtered water is pumped to the distributing mains by the high duty pumps, located in the pumping station.

Wooden chemical tanks are provided, which are located on the upper floor of the building. These are equipped with rotary mixing blades, which are actuated through suitable shafting and gearing, with a crank conveniently located for use by the operator.

These tanks are provided with orifice basins with valves, by which the quantities of chemicals are controlled.

The wash pump and air blower are motor driven, and the entire control of the plant is accomplished from the upper floor or gallery.

The filter basins, being independent of each other, the process of filtration need not be interrupted up to the capacity of one basin during washing.

The Washing System.

The filtration plant machinery was built and installed by the Roberts Filter Manufacturing Company, Inc., of Darby, Pa., whose special design lies in the means provided for washing the beds. In this process the valve controlling the water supply from the subsidence basin is closed and the water drawn off the bed until the wash troughs are uncovered. The valves leading to the sewer are then opened, allowing all sediment and wash water to run off. Air is then introduced through the manifold, as described above, which agitates the sand bed and detaches the sediment that has collected. This being accomplished, the air is shut off, the wash pumps started, and water applied through the water manifold, in a reverse direction to that of filtration. This wash water carries into the sewer all sedimentation that has been loosened by the air, the sand, being now clean and, after valves are arranged, ready for filtration to be started.

A period of about ten minutes is required for washing, the frequency depending on the amount and condition of water passing through the filter.

Loss of head gauges are provided, equipped with indicating dials and a clock arrangement driving a recording chart through which the condition of the filter beds is recorded, and a general check kept on the operation of the plant.

The plant has been in operation since March 1, 1916, and most satisfactory results are being obtained, the waters of the Saskatchewan River containing considerable sediment, especially during the early summer months.

Owing to the absence of metering devices on the water mains and the small amount of water being consumed, the actual cost of treatment in this plant has not been derived.

*Superintendent Waterworks Department, The Pas.

A General Discussion of the Extent to which Sewage can be Purified by Methods of Artificial Treatment Now in Use

All of the fundamental principles of sewage disposal and treatment now available had been recognized and actually utilized 25 years ago. Coarse screening has been practiced at Boston since 1884, and the Massachusetts Metropolitan Sewerage Commission put the Deer Island submerged outlet into use in 1895 for the purpose of furnishing adequate dilution to the coarsely screened sewage from the northern portion of the Metropolitan District. Paris and Berlin have been applying their sewage to broad irrigation farms for more than 30 years; the Welsh town, Merthyr Tydvil, treated its sewage by intermittent sand filtration as long ago as 1871. Sedimentation was used in England many years ago, and in 1870 chemical precipitation was well established there. Over 25 years ago Webster had invented an electrical method in which the suspended matter was precipitated by a process closely akin to chemical precipitation, and combining therewith, at least in principle, the killing of organisms, or disinfection.

The progress of the last 25 years has been in acquiring a correct perspective of the problems of sewage disposal, a better understanding of the principles upon which the processes of sewage treatment are based, and in perfecting such processes and the means of applying them. Much progress has been made along these lines, and there are now a number of modifications of each of the fundamental processes in use a quarter century ago.

It should not be inferred from the foregoing that little real progress has been made during this time, for this is not the case. Marked improvement has been made in screens, particularly those intended for the removal of the finer suspended particles. The laws affecting sedimentation are better applied, the most radical and important changes being those due to the theories that the period of retention in tanks should be reduced to a minimum consistent with efficiency in removal of those solids capable of settling in a reasonable length of time and that the settled solids should be promptly removed from contact with the partially clarified sewage. The greatest advance in the art has been the development of the process of bacterial oxidation by means of surface contact in bacteria beds. This process, as applied in intermittent filtration through sand, was comparatively well known 25 years ago, but the difficulties resulting from lack of suitable natural sand deposits led to the discovery of means of using other material, such as cinders and broken stone, by devices known as contact beds and trickling filters. These two methods, although involving substantially the same principles as intermittent filtration, generally accomplish much different results and have proved to be substantial aids in the solution of the sewage treatment problem in many places. Disinfection has made distinct advance and whereas it was hardly more than an experiment 25 years ago, its value for safeguarding water supplies and shellfish layings has now been demonstrated.

At the present time we are just over the threshold of a newly discovered process known as the activated sludge treatment. While the fundamental principles upon which it depends may not have been fully ascertained, the information available indicates that they are substantially the same as those of the processes now used.

The extent to which sewage can now be purified by practical methods was recently reviewed in a paper by Harrison P. Eddy, of Metcalf & Eddy, Boston, before the Engineers' Society of Western Pennsylvania. The present article is extracted, largely, from Mr. Eddy's paper.

COMPOSITION OF SEWAGE

In order to consider intelligently the several available methods of sewage treatment and their relation one to another, it is necessary to obtain a clear understanding of the general ingredients of sewage.

The physical condition of the principal constituents of a hypothetical sewage of medium strength are shown in diagrammatic form by Table I. It should be noted that in this illustration there are three classes of substances—suspended, colloidal and crystalloidal. The first and second of these can be removed physically without change in composition, while crystalloids are dissolved and must be changed in chemical composition before they can be removed or altered in character. It will also be seen that 400 parts per million are organic and 400 parts are inorganic or mineral. The latter substances are not ordinarily capable of producing putrefactive conditions, and the problem of sewage disposal is concerned almost wholly with the organic matter. This is disposed as follows:

Settling solids	100 parts
Suspended colloids	100 parts
Dissolved colloids	40 parts
Crystalloids (dissolved)	160 parts
Total	400 parts

The settling and colloidal substances, therefore, constitute 60 per cent. and the dissolved crystalloids but 40 per cent. of the total organic matter.

Where sewage is deprived of its objectionable characteristics by artificial treatment, one or both of two fundamentally different processes are generally employed; first, the actual removal, or taking out of the sewage, of certain constituent parts, as for example, such substances as paper, corks and garbage which may be removed by screens; second, the conversion of putrescible organic matter into stable substances. The former class of constituents is confined primarily to the suspended matter, while the latter comprises both suspended and dissolved substances.

DILUTION

All sewage must ultimately reach natural streams or bodies of water. When the quantity of sewage is small in comparison to that of the body of water into which it is discharged, sewers are usually designed to empty their contents directly into it, without previous treatment. Under such conditions the

Table I.

- Total Solids, 800
  - Suspended Solids, 300 (by filter paper)
    - Settling Solids (2 hrs.), 150
      - Organic Settling Solids, 100
      - Mineral Settling Solids, 50
      - → 150 Settling Solids
    - Suspended Colloidal Solids, 150
      - Organic Suspended Colloidal Solids, 100
      - Mineral Suspended Colloidal Solids, 50
      - → 200 Colloidal Solids
  - Dissolved Solids, 500
    - Dissolved Colloidal Solids, 50
      - Organic Dissolved Colloidal Solids, 40
      - Mineral Dissolved Colloidal Solids, 10
      - → 200 Colloidal Solids
    - Dissolved Crystalloidal Solids, 450
      - Organic Dissolved Crystalloidal Solids, 160
      - Mineral Dissolved Crystalloidal Solids, 290
      - → 450 Crystalloidal Solids
  - → Total Solids, 800

Physical Condition of Principal Constituents of Sewage of Medium Strength (Parts per Million).

Note: The suspended solids include all substances retained upon ordinary laboratory filter paper. "Dissolved" colloids is a term coined to apply to substances which will readily pass through the filter paper but which are colloidal.

waters are able to assimilate the organic matter, a process constantly going on in nature.

The velocity of a flowing stream may be a very important factor in the disposal of sewage by dilution, for it may thus be enabled to convey the suspended and dissolved sewage matter to a large body of water where ample dilution is afforded, in so short a period of time that the ill effects of the admixture of sewage with even a relatively small quantity of river water may not become evident.

In general, however, the sewage matter must be changed from its natural putrescible condition, either into innocuous mineral substances or into other matters which are organic in nature, but relatively stable, so that they cannot be the cause of putrefaction. Such a change is brought about through the agency of living organisms, the most numerous and probably the most potent of which, in the majority of cases, are bacteria although the microscopic organisms, such as various kinds of algae, are exceedingly important factors in the cycle through which the constituents of organic matter are continually passing in Nature's process of transforming organic matter into mineral substances and these back again into organic matter.

It may be said safely, therefore, that practically the whole process of sewage oxidation in nature, appears to depend upon the micro-organisms. In artificial treatment, also, practically all methods involving oxidation or organic matter appear to depend upon living organisms and their products. So it is important to bear in mind that to secure effectiveness and efficiency it is necessary to create conditions favorable to the growth and reproduction of these minute organisms. Such conditions are provided by natural agencies when the relative proportion of sewage to diluting water is small. It is necessary to adopt artificial means only when the relative quantity of sewage becomes disproportionate to the capabilities of natural waters for its oxidation. Under these conditions the first step toward artificial control may be to create a more complete distribution of the sewage through the diluting waters, thus overcoming the effect of an overload due to the concentration of the sewage in a small portion of the diluting water. The advantage of this is often overlooked.

ARTIFICIAL MEANS OF SEWAGE TREATMENT

The objects of artificial treatment, with the methods by which they are attained, may be classified as follows:

A. To prevent waters into which sewage is discharged from becoming offensive to the eye on account of coarse floating and suspended matter.

Screening.

(a) Coarse.

(b) Fine.

B. To prevent such waters from becoming malodorous.

1. Sedimentation.
   - (a) Rapid in grit chambers.
   - (b) Slow in settling basins.
     - Plain.
     - With septic action in single-storey tanks.
     - With sludge digestion in two-storey tanks.
     - With chemical precipitation.
     - With electrolysis and chemical precipitation.
     - With colloiders.
2. Aeration, contact with the organisms or sludge from previously aerated sewage and sedimentation.
3. Contact bed treatment.
4. Trickling filter treatment.
5. Intermittent filtration.
6. Broad irrigation.

C. To prevent the introduction into the water of germs of disease.

Disinfection.

The treatment of sewage may be accomplished by a single process in some cases, but usually it is effected by a series of steps, the degree of purification increasing with each successive stage. If raw sewage may be discharged into natural waters without creating objectionable conditions other than offending the sense of sight, the simple process of screening may suffice, but if it is necessary to remove more of the matters likely to settle, sedimentation may be adopted as an adjunct to or substitute for screening. Where the diluting waters are so limited in quantity that it is necessary to supplement their powers of oxidation, some method of artificial oxidation must be adopted; such, for example, as filtration through beds of sand or stone which form the habitat of bacteria and other organisms capable of bringing about the more or less

complete and rapid oxidation of the organic matter of the sewage. Under still more exacting conditions it may be necessary to go further with the removal of pathogenic organisms. The final process would then be disinfection, through which a large proportion of the harmful bacteria may be eliminated even from settled sewage. In such a case the treatment would involve four successive steps, namely, screening, sedimentation, oxidation by filtration or other means, and disinfection.

SCREENING

Municipal sewage contains many relatively large and coarse substances such as cloth, paper, garbage and pieces of wood, which may interfere with pumping and other machinery and prove unsightly in the waters into which the sewage is discharged.

Such substances may be removed by coarse screens, which often consist simply of parallel iron bars, or gratings, set vertically or at an angle of from 30 to 60 degrees with the horizontal, through which the sewage flows and upon which the very coarsest of the suspended and floating matter is retained.

Coarse screen will remove only from 5 to 10 parts per million of suspended matter originally contained in the sewage. This is usually sufficient for the protection of machinery and is regarded as sufficient for all purposes in some cases where sewage is discharged into large quantities of diluting water, as into the tidal waters of Boston Harbor off Nut Island.

If, however, sewage is to be discharged in relatively large quantities into waters used for boating and other pleasure purposes, coarse screens cannot be relied upon to remove all of the suspended matters which are recognizable as being of sewage origin and which, therefore, may be considered as offensive to the sight. Where such substances must be removed and also where a somewhat greater reduction in the organic matter is required, fine screens may be used, either by themselves, or supplementary to the coarse screens. Numerous types of fine screens have been perfected and placed upon the market, among which may be mentionel the Weand screen, first installed at Reading, Pa.; the Jennings screen, used at the Union Stock Yards in Chicago; and the Reinsch-Wurl screen used in Germany and being installed to a limited extent in this country. The Weand screen consists of a horizontal revolving drum covered with a fine mesh screen. The sewage is discharged into this drum at one end and flows out through the cloth, which retains the suspended matter until it is washed off into suitable receptacles by jets of water. The Jennings screen is of the moving band type, the lower end being submerged in the sewage, which flows through the screen cloth, which retains the suspended matter and carries it up out of the sewage. When the screen has passed over the pulleys at the top, the screenings are blown off into a pit by a jet of compressed air applied to the back side of the screen. The Reinsch-Wurl screen which is typical of its class consists of a disk of perforated metal, with or without a frustrum of a cone attached to its centre, the whole being mounted on a shaft whose inclination from the vertical determines the degree of tilting of the disk. As the screenings are raised above the surface of the sewage by the revolving disk and cone they are swept into a circular gutter, by brushes on the ends of the arms of a large spider. Where the screen is surmounted by the frustrum of a cone the side of the cone is cleaned by a brush inclined against its surface.

The quantity of suspended matter removed by the fine screens varies with their efficiency and the quality of the sewage. Such screens may remove from 20 to 70 parts, averaging perhaps 50 parts per million of suspended solids.

Sewage Treatment by Sedimentation

It has been claimed sometimes that with the most effective fine screens the organic matter may be removed to such an extent as to greatly reduce the oxygen requirements of the sewage, and thus make it possible to dispose of a much greater quantity of screened than of raw sewage in a given quantity of diluting water. The cencensus of opinion, however, appears to be that while the reduction of organic matter by fine screenings may be considerable, it will not be enough to greatly increase the quantity of sewage which a given stream or body of water may receive and remain in a satisfactory condition. Grounds for this opinion will be apparent when it is considered that much of the coarse suspended matter in sewage consists of materials like paper, matches and coffee grounds, which are relatively stable organic substances and which do not constitute so great a tax upon the diluting power of the water as equal quantities of fecal and other polluting substances which are more finely divided and consequently which are not so completely removed by screens. Therefore, where it is necessary to increase the quantity of sewage which may be discharged into a body of water, sedimentation in some form is generally adopted.

The grit chamber ordinarily is merely an adjunct to the main process of sewage treatment, its function being to remove the coarser sand and gravel commonly called grit, which might cause excessive wear of moving parts of machinery, or cause deposits in tanks or elsewhere which would prove more expensive to remove from such tanks than from grit chambers. There is much diversity in the design of such chambers, the older ones and those most commonly in use in England being so large that they permit the sedimentation not only of the grit or mineral matter, but also of much of the organic sewage matter. Such deposits are relatively large in quantity and exceedingly offensive in character. They are removed by manual labor, being shoveled, after draining, into buckets, or they may be dredged by various types of excavators capable of removing the grit from beneath the surface of the sewage, thus avoiding the emptying of the chambers. The more modern type of grit chambers, which may fairly be said to have originated in Germany, consists of one or more narrow channels through which the sewage is allowed to flow at velocities closely approximating 1 foot per second, at which the sand and gritty matter will deposit. These chambers are in turn shut off and drained, and the grit removed, ordinarily by manual labor. Under the best conditions this grit consists of a mixture of various sizes of sand comparatively little of which is finer

than ordinary mortar sand. It contains relatively little organic matter, perhaps from 15 to 25 per cent., and is less offensive than the grit removed from the larger and older type of chambers, where the velocity of flow is much lower. The quantity of grit removed will vary roughly between 10 and 40 parts per million.

Plain Sedimentation

Plain sedimentation may be assumed to mean the process by which sewage is allowed to flow through horizontal or vertical tanks at velocities sufficiently low to permit substantially all of the suspended matter capable of settling in a reasonable length of time, to fill to the bottom of the tank, where it accumulates in the form of a mud, commonly called sludge.

It is necessary to remove this accumulation from time to time and it may be said in a general way that a plain sedimentation tank should be cleaned at intervals of from 3 to 6 weeks, depending upon the season of the year, or, more accurately, the temperature of the sewage. The object is to remove the sludge before decomposition becomes very active and causes portions of it to rise through the sewage, form a well-defined scum, or pass out of the tank in the effluent.

Septic Tank Treatment

The septic tank, a patented device, is similar to the plain sedimentation tank; in fact there is scarcely any difference between the two except in the method of operation. The septic tank is distinguished by being so operated as to ensure the absence of dissolved oxygen in the effluent and to permit of more or less complete decomposition of the solid substances in the sludge. The decomposition is accompanied by the production of large quantities of gas, due to biological action, and the gases are retained until the mass becomes sufficiently bouyant to rise rapidly to the surface, sometimes giving to the tank the appearance of ebullition. With these gases also rise large quantities of suspended matter, much of which is relatively coarse, especially if the sewage has not been screened, or has been screened only through coarse racks. This suspended matter holds entrained the gases, which in turn cause it to float at the surface of the tank. Repeated ebullitions of this kind cause the gradual accumulation of greater and greater quantities of this floating coarse suspended matter, which ultimately forms a thick scum attaining in some cases a thickness of two feet or more.

The septic tank, which at one time was looked upon with favor by some engineers, did not prove as satisfactory as was originally anticipated. The continuous evolution of gas from the sludge causes large quantities of suspended matter to be continually rising and falling through the liquid in the tank, which carries much of it out of the tank, thus defeating in part the object of the process. Furthermore, the changes due to anaerobic decomposition of organic matter appear to render the sewage rather more difficult to treat by processes of oxidation than fresh sewage which has not become impregnated with the gases and other products of decomposition. Septic sewage also frequently possesses an exceedingly offensive odor.

Two-storey Tanks

A recognition of the defects in the septic process led to the construction of two types of two-storey tanks: one, by Mr. William O. Travis, of Hampton, England, and another by Dr. Karl Imhoff, of Essen, Germany. The theory upon which these types of tank is based is that the sewage should be allowed to pass through the sedimentation chamber as rapidly as is compatible with the practically complete removal of the suspended matter capable of settling in a reasonable length of time and that the sludge should be permitted and encouraged to decompose in a chamber separate and distinct from that in which the sedimentation process is going on. The result of this plan is an effluent deprived of its suspended matter, and which has not come in contact with the decomposing sludge, and therefore does not contain the gases and other products of decomposition, nor the finely divided suspended matter so prevalent in effluents from the septic tank. In fact where sewage is rather dilute and the temperature is moderate the effluent from such tanks frequently contains dissolved oxygen. Sections of the Imhoff tank are shown in Fig. I.

Work Performed by Sedimentation

It may be assumed that of the 150 parts suspended solids capable of settling in two hours, perhaps 130 parts can be removed by efficient plain sedimentation. This is based on a tank efficiency of about 90 per cent.,

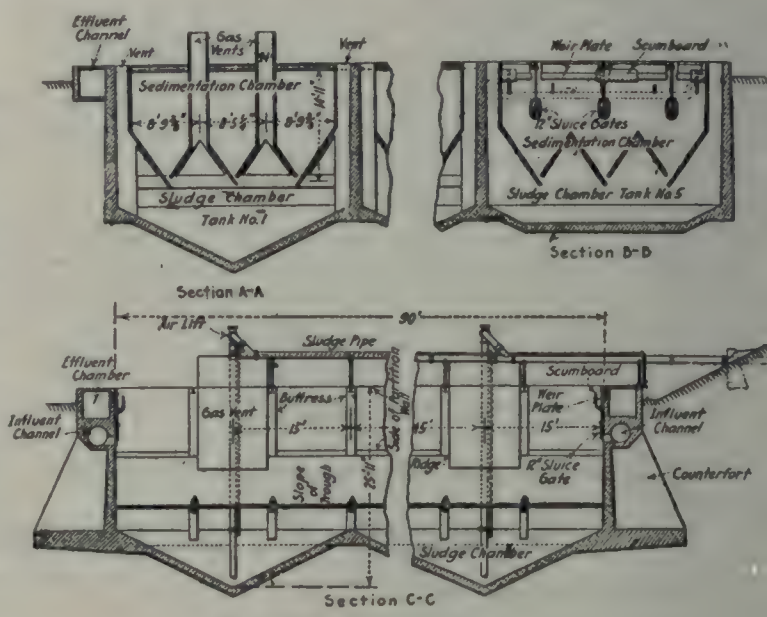


Fig. 1—Sections of Imhoff tank.

computed upon the removal of settling solids. Upon this assumption the effluent will contain suspended colloidal matter which, together with the remaining settling solids, will amount to about 170 parts per million. In addition the effluent will contain about 500 parts of dissolved solids, of which about 50 parts has been classified as dissolved matter, 40 per cent. of which may be assured to be organic.

Chemical Precipitation

If further improvement is desired a part of the remaining settling solids, suspended colloidal solids and dissolved colloidal substances may be removed. To accomplish this recourse was had many years ago to chemical precipitation. This consists of adding to the sludge certain chemicals like lime and sulphate of iron, which react upon each other in such a manner as to form a flocculent precipitate, which gathers in large flocculi which enclose and attract the finely divided suspended matter and some dissolved colloidal matter, and by their weight carry these substances to the bottom. In this way it is possible to greatly reduce the suspended solids and to effect some reduction in the so-called dissolved matter. This method has been

subject to much objection on account of cost, the difficulty of disposing of the large quantity of sludge produced and of the partial removal, only, of the organic matter contained in the original sewage. Chemical precipitation is generally utilized by itself, although in some cases, particularly in the treatment of industrial wastes, it may be introduced as an adjunct to and following plain sedimentation and it may be used as a treatment preliminary to some method of filtration.

Sedimentation with Aeration

The most recent development in the art of removing suspended and colloidal substances from sewage is that known as the "activated sludge process." By this means it is possible to remove from ordinary municipal sewage a large part of the suspended and colloidal matter. As yet the installations are experimental, but are giving promising results. Suspended solids may be removed almost completely in the remarkably short time of four hours or even less. This process will be described in succeeding pages.

Work Performed by Sedimentation Aided by Methods of Removing Colloids

It has been pointed out that the effluent from efficient plain sedimentation will contain about 170 parts per million of settling and suspended matter, and about 50 parts of so-called dissolved colloidal matter, making a total of 220 parts per million.

Several ways of removing a portion or the whole of this matter have been suggested, among which may be mentioned sedimentation in tanks equipped with many vertical slats, or colloiders, chemical precipitation and the activated sludge treatment. The last method will accomplish more than is practicable under ordinary working conditions by either of the others, and in addition it will at the same time oxidize some of the dissolved substances; therefore, it cannot fairly be considered as simply a means of removing suspended and colloidal matter.

The most effective method devoted strictly to the removal of such substances, is chemical precipitation, by which much of the settling solids and colloidal matter can be removed. In addition to the 130 parts of settling solids which may be removed by plain sedimentation, about 160 parts of the settling solids and colloidal matter which escapes this process can be removed by chemical precipitation, leaving in the effluent from this process 60 parts per million, or less, of settling and colloidal matters. It is possible to go even further, but the cost of doing so has usually been prohibitive.

The effluent from sedimentation tanks may be discharged with propriety into some bodies of diluting water, but in many cases it is necessary to carry the process of purification further. Where chemical precipitation will provide a suitable effluent the choice between this method and some means of oxidation will depend upon their relative costs.

Contact Bed Treatment

Perhaps the most logical step ahead from tank treatment is the application of sewage to the contact bed. Such beds are built in water-tight compartments filled with broken stone or other similar medium to which bacteria become attached. This mass of stone is thus converted into an active bacterial medium over which the sewage gradually flows during the filling and discharging periods, and in contact with which it remains during the contact period. Such beds are operated in cycles of which the following is typical:

Time of filling	1.0 hour
Time of contact	0.75 hour
Time of emptying	0.25 hour
Time of resting	6.00 hour
Time of cycle	8.00 hour

While the sewage is in contact with the bacterial film or jelly surrounding the stones, its colloidal and dissolved substances are attracted to these films in which the bacteria are living and digesting the organic matter, thus brought to them. The changes which occur in the contact bed apparently consist of the initial removal of suspended and colloidal matters, its partial oxidation and the oxidation of matters in solution. By this process it is possible to so change the character of the sewage that even when undiluted it

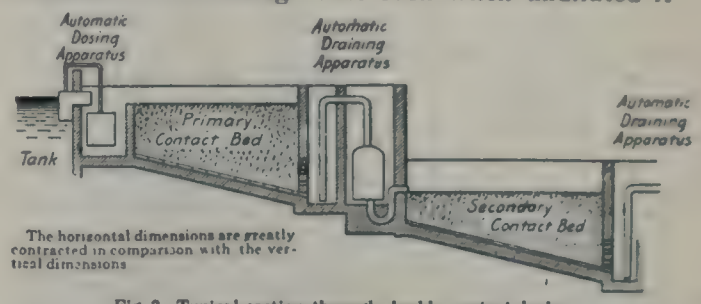


Fig. 2—Typical section through double contact beds.

will remain stable or, in other words, will fail to putrefy, and may, therefore, be discharged into streams or bodies of water much smaller than those into which ordinary sedimentation tank effluents could properly be discharged. The effluent, however, is usually turbid, contains some suspended matter and is far from being fully oxidized. This process, which has met with some favor, both in this country and abroad, usually provides for two contacts, the sewage being applied to a secondary bed after it has remained in the primary bed during the requisite period of contact. Fig. 2 shows a typical double contact bed.

(To be continued)

The Dick Well Drilling Machine

The Dick Well Drilling Machine Company, of Bolton, Ont., have been specializing on the manufacture of well-drilling machines for many years, and have supplied a lot of machinery to drilling contractors throughout Canada. They manufacture drilling machines that

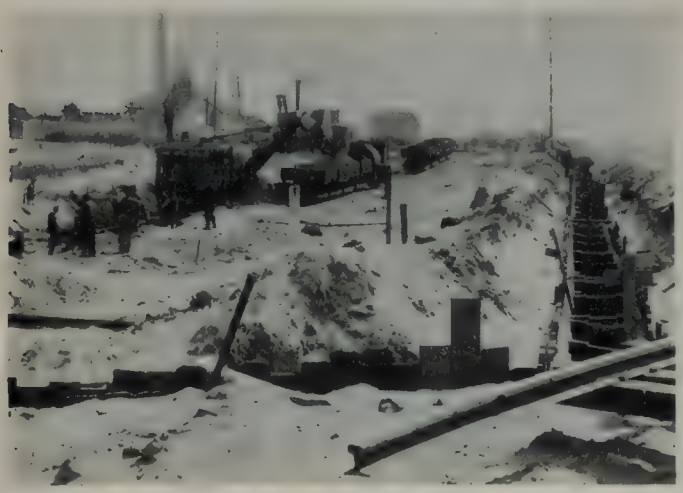
will drill holes any size or depth, but their most popular machine, a "well" drill, which we illustrate herewith, will drill a hole any size up to six inches and any depth up to 500 feet. Besides manufacturing machines the Dick Well Drilling Machine Company employ experienced drillers who are open to take well drilling contracts in all parts of Canada.

Unusual Construction Difficulties Met in Installing Mechanical Filtration Plant

THE city of Toronto some half dozen years ago installed a slow filtration plant on Toronto Island, but rapid growth of population has made it necessary to increase the capacity of the water purification system. After due consideration it was decided that the system best suited to conditions in Toronto would be served by a rapid or mechanical filtration plant, and the Ransome type was decided upon. The design and tender of the John ver Mehr Engineering Company and William Cowlin & Son (Canada), Limited, amounting to $1,066,282, was accepted. In the article which follows it has not been the intention to describe the operation or explain the plan of this filtration system, but merely to describe briefly a few of the more interesting details of construction, many of which are entirely unique. The work on this plant is now nearing completion. It will consist of 10 filtration units, each with a capacity of 6,000,000 gallons per 24 hours, so that, when operating at full capacity, this plant alone will supply the maximum peak demand to date. The main portions of the plant are: The filtration house proper; a boiler and pumping-house; a chemical house, in the basement of which is the coal storage; the section well; and a large pressure tank, in which water is stored for washing the filters.

Toronto Filtration Contract.

The construction of the plant was specially interesting owing to the peculiarities of the site. The whole island is a water-logged sand bar, the highest point on the site of the proposed works being only about 4 feet 6 inches above the water level. The largest building, which is the filter house, measuring 277' x 123', has a formation level at the underside of the floor of 9 feet below high-water mark, and is situated, at the nearest point, within 25 feet of the lagoon. Before the excavation for this building, amounting to about 19,000 yards, could be commenced, it was necessary to remove the water from the area.



View of site looking south at commencement of excavation. Part of drainage trench cutting off site from lagoon is shown on right. One of the three temporary pumping stations on the trench is seen in background.

Drying Out the Site.

The method adopted in the construction of the already existing slow sand filtration plant carried out about six years ago was to surround the site with drainage canals excavated by scows to a depth below the formation level. These canals, when completed, were kept pumped down to a lower level than the site, thus draining the water from the site and preventing the inflow from all the surrounding water-logged area. Owing to the cramped space surrounding the new plant and the nearness of the lagoon, this method was not applicable. Advantage was, however, taken of one of the former existing drainage canals which ran along the east side of the new filter house.

Corner of Filter House, showing concrete floor slab and form work for Concrete foundation wall.

This was dammed back from connection with the lagoon, and was then kept pumped to below the level of the filter house formation. The north, west, and south sides were surrounded with a sheeted drainage trench, carried to a depth of 2 feet below the formation. On this drainage trench two temporary pumping stations were erected, and the water in this trench was kept at all times down to the same level as the drainage canal mentioned—that is, 2 feet below the bottom of the filter house floor.

Running the whole length of the site there existed a 60-inch wrought iron pipe, and also a 48-inch wooden pipe, both of which were open to the lagoon. The latter was below the formation of the floor, and after the connection to the lagoon had been cut, this was used as a direct connection between the two temporary pumping stations, and was found very useful when it was necessary for any reason to temporarily shut down one or other of the pumping stations.

The Excavation.

The excavation was removed with a "Marion" revolving shovel. It was loaded into dump cars and dumped at selected places alongside the lagoon. The drainage canal and trenches worked very efficiently, the formation surface obtained being just damp

enough to compact the sand without causing it to be wet enough to yield to any extent under pressure. It was interesting to note that after the drainage arrangements had been running for several weeks the flow of water obtained through the surrounding strata was much decreased, owing, no doubt, to a partial clogging of the spaces in the sand with finer particles.

Filter House looking south, showing concrete raft and side walls completed and brickwork being commenced. Two railway cars which have been brought across in the ferry scow are seen at the S.W. corner in process of being unloaded by the cableway.

Any excavation required for manholes, drains, etc., below the formation level of the floor showed very fine running sand, and the work was expensive and slow.

Practically the same conditions existed in the excavation for the pumphouse building. The general excavation for the boiler house and the chemical house did not go below water level, and no difficulty was experienced with these.

The Filter House.

The filter house stands on what is practically a concrete raft, the floor of which is about 2 feet in

Suction well caisson in course of construction, showing forms for intake pipe openings.

thickness; the side walls are about 6 feet in height, and also average 2 feet in thickness. This concrete was laid in bays, with a toothed expansion joint between each bay. Two concrete mixers, one electrically driven and one steam driven, were used, and the bulk of the concrete was placed with a movable cableway spanning the site.

There were no special features in the construction of the superstructure calling for description.

The Suction Well.

The suction well, the bottom of which goes down to a depth of 25 feet below high water, was the deepest excavation on the whole filtration site. This was sunk as a caisson. An iron shoe was first built up on the site and the concrete forms erected over this. The concrete was run in sections 7 feet in height. When two sections, or 14 feet high, had been poured the caisson was sunk by clamming out the sand from the interior.

The work of sinking evenly was rendered more difficult owing to the peculiar plan of the caisson. For about three-quarters of the circumference it is circular, with wall 18 inches thick. The remaining one-quarter of the circumference is one straight chord, with a thickness of 6 feet. The difficulty of removing

Foundation of Pump House under construction. All concrete was placed by the cableway shown.

the material from below this wide portion was got over by putting down a semi-circular chamber of Lackawanna sheet piling outside the caisson, so that at this wide 6-foot portion the material could be removed from outside as well as inside. The caisson sunk well and evenly to within 6 inches of its final position. No guides were used, and the caisson was kept plumb by using the water jet on any side which showed a tendency to hang.

The formation level of the caisson proved to be in very fluid running sand. The last five feet of excavation could not be removed from the interior of the caisson owing to the material boiling in, and some tilting of the caisson took place due to this. Excavation operation was, therefore, suspended until the pipe trench approached close enough to draw the water from the surrounding strata, thus reducing the pressure upwards on the caisson formation. The slight tilt was then rectified. A sump was then sunk in the centre of the caisson bottom, radial drains of gravel were made to this, the whole was covered with a light sheet-iron blanket ,and the concrete bottom successfully placed on this.

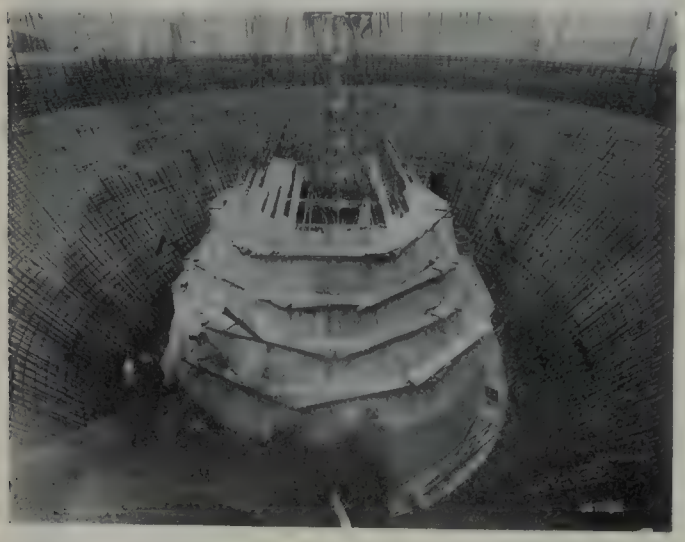
The Intake.

The intake consists of two 72-inch steel pipes, side by side, the water run being at a depth of 21 feet below

lagoon water level. Each pipe connects up to a valve chamber of the existing city intake. This was difficult, hazardous, and costly, owing to the very liquid condition of the fine sand and the close proximity of the existing works. It was necessary also to lay the intake pipe close underneath the two pipes carrying the existing water supply. Other obstacles, such as an abandoned wooden stave pipe, crib work, old concrete pipes, and logs were also encountered. The length of 95 feet from the south, working northwards, was sheet piled on both sides, and the new pipes laid and concreted under water by means of a tremie and divers. The northmost half of the intake was sheeted in a similar manner, but in this case the water was pumped out and the pipes laid and concreted in the dry. The latter was the cheaper and quicker method, but was not applicable on the first section, owing to the proximity of existing structures and the existing pipes crossing the trench.

Chemical House and Coal Storage.

The chemical house and coal storage building offers no special features of interest from the point of view of construction. A large reinforced concrete cone involved somewhat complicated reinforcement and form work, with naturally corresponding high cost. This building, and also the foundations of the pump house, were poured from a concreting tower. This tower was equipped with an electrically driven Ransome concrete mixer, which was supplied by a



Interior of large reinforced concrete cone in chemical house in course of construction, showing reinforcement of outer cone and form work for inner cone.

large stone and concrete bin, situated close to the wharf on the lagoon. Stone and sand were brought in scows alongside the wharf and were clammed by a 15-ton, 8-wheeled Industrial crane directly into the concreting bin. In this way there was a minimum of handling of the material.

Loaded Freight Cars Across the Bay.

The works involved the conveying to the Island of many thousands of tons of material. The great bulk of this material arrived in Toronto in freight cars. These were delivered to the contractor's wharf at the foot of Spadina Avenue. The sidings at this wharf were continued to the water's edge and the freight cars were run on a scow specially constructed to act as a train ferry. This scow, with the cars on board, was then taken to the Island by a tug and the car was pulled off at a specially constructed temporary wharf onto the contractor's sidings at the works. The pulling off and the moving on the sidings was done sometimes by a 15-ton, 8-wheeled Industrial locomotive crane, but when this was not available the cars were drawn off and moved on the sidings by an electrical hoist.

Three hundred cars have been safely taken across and brought back without a hitch, and with a great economy in the labor and handling of material and waste due to breakage.

Complete Contractor's Plant at the Works.

Owing to the situation of the works it was considered advisable to have a carpenter's shop, machine

Interior of reinforced concrete coal store. This building is semi-circular. The S.W. corner is shown.

and fitting shop, and a blacksmith shop on the works. All the plant in these shops is electrically driven.

Throughout the whole work the plant, wherever possible, was driven electrically, use being made of hydro power. Several of the more important pumps (the stoppage of which even for a short time would involve very serious consequences) were supplied with

Part of interior of 50 ft. diameter filter tank, showing the iron bases on which sand cones rest, the rows of collector pipes in the bottoms, and the extractor pipes in the slots between the sections.

a steam standby, and this standby was used to reduce the peak load on the electrical plant.

The site of the works was lighted by a number of

5-light clusters mounted on 40-foot poles, which poles also carried the distribution of the power supply.

The great majority of the motors used were supplied by the Lancashire Dynamo and Motor Company, Ltd.

One of the most useful items of plant was the 15-ton, 8-wheeled Industrial locomotive crane referred to, which did the whole of the handling of the heavy Lackawanna steel sheeting in the intake. It also excavated all the material in the intake and backfilled the greater bulk, and was employed also in setting the 72-inch steel intake pipes. It was also largely used in the filling of the concreting bins above referred to.

Considerable trouble was experienced in keeping in running condition the car tracks laid down around the site owing to the very loose nature of the sand. In dry weather it was found practically impossible to keep the tracks properly packed.

The work was peculiar, in that for considerable periods during winter the Island was practically inaccessible, owing to ice on the bay and lagoon, preventing navigation yet not being strong enough for traffic. During such times the men and material had to be conveyed to and from the western gap, a distance of about two miles.

The patents for the Ransome drifting sand filter, which are the main feature of the installation, are controlled by the John verMehr Engineering Company, Ltd., by whom the layout of the plant was also designed.

Contractors.

The general contractors for the whole of the work were William Cowlin & Son (Canada), Ltd.

The firms supplying machinery and equipment were: Cast iron pipes, Canada Iron Foundries, Ltd., head office, Montreal; valves and operating tables, Glenfield & Kennedy, Ltd., Scotland (Montreal office, 314 Coristine Building); venturi meters, Builders' Iron Foundry, Providence, R.I.; water tank, Chicago Bridge Company, Chicago, Ill.; steel sheet piling, Lackawanna Steel Company, Buffalo, N.Y. The remainder of the equipment was supplied by Toronto firms: Filter tanks and intake pipe, Thor Iron Works; De Laval pumps and generator, Turbine Equipment Company; cranes, J. T. Hepburn, Ltd.; switchboard, Canadian Westinghouse Company; chimney, Custodis Canadian Chimney Company; structural steel, Dominion Bridge Company; steel sash and chequered plate flooring, A. B. Ormsby & Co., Ltd.; skylight, Henry Hope & Sons; glazing, Pilkington Brothers; tiled roof, Rennie & Sons; painting, Murray-Kay, Ltd.; galvanized iron work, W. E. Dillon Company, Ltd.; heating, Bennett & Wright Company; boilers, International Engineering Company; electric lighting, E. F. W. Salisbury; small cast iron piping and special castings, Standard Foundry; sherardizing pipes, Chambers Limited; wharf, David Arnot; bricks, Don Valley; cement, Canada Cement Company.

Mainly Constructional

East and West—From Coast to Coast

Milton Foundry, Limited, have been incorporated with a capital of $40,000, head office Milton, Ont.

The Manitoba Steel Foundries, Limited, has been incorporated with a capital stock of $300,000, head office Winnipeg.

The total number of building permits issued for July in Woodstock, Ont., was eighteen, and the amount to be expended, $17,100. This is an increase of $6,000 over the same month last year.

The Canadian Steel Foundries propose to build an addition, 140 x 40, to their muck mill at Welland. The addition will be of steel construction and will cost $6,000. Ryan & Gardiner have the contract.

More farm tile is reported to have been sold at Stratford, Ont., this year than ever previously, the demand being stimulated by the unusually wet spring, which showed the pressing necessity of tile drainage.

Dominion Vaults, Limited, have been incorporated with a capital of $100,000, head office, Toronto. They will carry on a manufacturing business and also that of public and private contractors in all their branches.

The General Contractors' Association, at San Francisco, which is part of the Building Trade Employers' Association, has voted for an open shop policy, in line with a similar declaration made some weeks ago by the Chamber of Commerce.

The building permits issued at Medicine Hat, Alta., for the month of July amounted to $55,090, as against $3,000 for the same month last year. The permits for the first seven months amount to $344,100, as against $53,260 for the same period last year.

An increase in waterworks power is required at Hamilton, Ont., and the installation of steam turbine pumps for additional capacity is considered. It has also been suggested that the city couple up with the Cataract company for emergency purposes.

The Ottawa Paint Works, Limited, has been incorporated with a capital stock of $200,000, head office Ottawa, and will take over as a going concern the business now carried on by the Ottawa Paint Works and the Ottawa Varnish Company, Limited.

The building permits issued in Chatham, Ont., during the month of July amounted to $61,100, an increase over the same month last year of $20,450. The total for the first seven months of this year is $217,270, as compared with $122,650 for the corresponding period in 1915.

Washed Sand & Gravel, Limited, have been incorporated with a capital of $60,000, headquarters Toronto, and will carry on the business of dealers in sands, gravels, stone, lime, cement and builders' supplies of all kinds. They will also manufacture sewer and field pipes, tiles, etc.

Commissioner Macallum has informed the Ottawa board of control that the cost of the new water redistribution system is to exceed the estimate of the engineers who designed it, Messrs. W. S. and R. S. Lea, of Montreal, by $100,000. The estimated cost was $420,000, and $361,000 has already been spent. The total cost will be $561,000.

The building permits issued in Vancouver, B. C., during the month of July this year numbered 29, value $156,465, as compared with 33 in July, 1916, value $171,065. The total number of permits for the first seven months of this year is 283, amount $590,515, as against 425 during the corresponding period last year, amount $1,238,031.

A new automobile highway through the Revelstoke National Park, in British Columbia, which has been completed for a distance of 11 miles, was formally opened recently by H. R. H. the Duke of Connaught. The area of the park through which the road leads is over 57,600 acres, being created by the Dominion Government by order-in-council on April 28, 1914.

The portion of the Toronto-Hamilton highway which runs through the central part of Burlington was recently uncovered for traffic. Work on the highway in the vicinity

of the town is progressing very favorably. The road is completed from immediately east of the Valley Inn hills, near Hamilton, to the Credit river, with the exception of two small portions.

The first contract in the installation of the sewer system of Burlington, Ont., is almost completed. This includes the laying of the water pipes on Water, Brant, Locust, Seneca, Ontario and Maria Streets and Burlington and Hurd Avenues, besides the force main from the pump house on Junction Street, near Rambo Creek, to the disposal plant on the Bell property.

The Joint Parliamentary Committee which has charge of the re-construction of the Parliament Buildings will hold a meeting shortly, at which the terms of the contract with Peter Lyall & Sons Company for building the structure, are to be finally decided upon. It is possible that the original terms may be revised. The committee has decided to call for public tenders on all material.

The claims of Doran and Devlin, contractors, regarding their work at Lemieux Island for the city of Ottawa being held up, are to be ignored. The contractors had written complaining that in June their blasting operations had been stopped by the city because of danger to the chlorinating plant and the delay had put them back at least two months. The city considers that there was plenty of other work they could have gone ahead with.

The highway which the Provincial Government are building from Montreal to Quebec is now sufficiently advanced to permit of automobile traffic between the two cities, with one or two detours. During the month of July a great deal of reconstruction work and re-surfacing was done and there have been nearly a score of rollers working at one part or another. The entire length of the road is about 171 miles. Stone block pavement, asphalt, concrete, and macadam have been used in the construction.

Economies are being effected by Mr. A. F. Macallum, Commissioner of Works, Ottawa, in connection with street paving. Hitherto, the practice of the city has been to lay a six-inch concrete base. The commissioner's policy is to have only a four-inch concrete base on streets where there is no possibility of heavy traffic during the life of the pavement. The paving is being done at a rate of about $2.00 per yard, where in the past the city has paid about $2.40. A case in point is the work on Daly Avenue.

Building activity in the Earlscourt district, Toronto, and the southern portion of York Township, is on the increase, according to a statement by Deputy Reeve F. H. Miller, of York Township Council. He stated that several enquiries had been received for factory site locations and that negotiations were under way for a paint and varnish factory on the old Belt Line at Fairbank; also, that enquiries had been made by a large firm of cement manufacturers regarding the establishment of a plant on the southern portion of the township.

In acknowledging the receipt of estimates on roadways from various counties, the Hon. Finlay G. Macdiarmid, Minister of Public Works for the province of Ontario, urges economy in road construction. After pointing out that a glut of work at high wages keeps men from the front, he says, "At the conclusion of the war it is fully anticipated that the opposite conditions will prevail. During that period of re-adjustment a serious economic condition may arise. I therefore recommend your county, as a patriotic duty, to delay as far as possible roadway expenditures."

The York Hotel Company, Limited, propose to build a $2,000,000 hotel in Toronto on the site of the present Yonge Street Arcade. W. S. Dinnick, of the Standard Reliance Mortgage Corporation, made application on behalf of the company, and the city council has approved the board of control's recommendation for a fixed assessment on the property. The building is to be fourteen storeys in height, built of white limestone and brick, and will be absolutely fireproof. It will have 600 guest rooms, a bathroom with each room, and will include a convention hall and other new features. It will have no bar. Guests will be received at the Victoria Street entrance. Messrs. George Post & Sons, of New York, are the architects.

The Allied Trades and Labor Council at Ottawa have protested strongly against the position taken by Commissioner of Works Macallum in his refusal to grant the demands of the corporation laborers an increase of 5c per hour on their present 25c rate. The special committee of the council have adopted proposals as to wages and conditions governing civic work and presented same for the consideration of the Board of Control. Eight of the building trade organizations have sanctioned the proposal and attached their signatures, the trades being bricklayers, stonemasons, stone-cutters, stationary engineers, plumbers and steamfitters, and painters. A rate of 30c. was put in for the laborers, and cement finishers 40c. The union rate and conditions have been strictly adhered to.

Personal

Controller Kent has been placed in charge of the waterworks system of the city of Ottawa.

Mr. Geo. H. Wilson has been appointed secretary of the civic works department of the city of Ottawa, upon the recommendation of Commissioner Macallum. His duties will include: charge of the clerical staff, secretary of the department, charge of complaints, charge of timekeepers, charge of garbage inspectors, oversight of cost accounting system and the purchasing for the department.

Obituary

William Yellowley, superintendent of the Canadian Locomotive Works, died very suddenly on August 7, at the age of 57 years. He was a native of Newcastle, England, and had been with the Works at Kingston, Ont., for over 15 years.

From Three Rivers comes the announcement of the death of Mr. F. X. Berlinguet, engineer and architect, of Quebec, aged 86. Mr. Berlinguet was one of the few honorary members of the Province of Quebec Association of Architects. He was president of the association in 1891-1892.

Peter S. Gibson, of Willowdale, York County, Ont., passed away recently at the age of 79. He was a well-known civil engineer and surveyor, being head of the firm of Peter S. Gibson & Sons, engineers and land surveyors. He was also engineer for York Township for over 35 years, and a member of the Board of Examiners of the Ontario Land Survey.

Mr. Samuel Boyd, one of the oldest and best known citizens of St. Catharines, Ont., died recently at his home in that city at the age of 85. Mr. Boyd was an expert stonemason and bricklayer, and for many years carried on business as a building contractor. For nearly forty years he was prominently identified with the Bricklayers' and Masons' Union.

On page 45 of the Contract Record of July 26th, an item appeared to the effect that contracts for the erection of machine shop and stores for the C. N. R. at Edmonton, Alberta, had been awarded to Nesbitt & Company, 10243-95th Street. This item should have read the E. M. Nesbitt Company, Limited, 10041-118th Street, Edmonton. The E. M. Nesbitt Company, Limited, are successors to Nesbitt & Miller, general contractors.

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An Improvement in Recruiting Methods

THE Dominion Government appears to have taken another step towards reorganization of our present ridiculous methods of recruiting, though the plan is being unfolded and developed with such care that at present writing no one appears to have any very clear conception of its working. It is safe to say, however, that the public will welcome almost anything the Government may suggest, since, being different, it must necessarily be an improvement. All we know in Toronto to date is that the matter has been placed in the hands of a young lawyer whose ability as an organizer must, of course, be known to the Government that appointed him even though it has escaped the observance of his friends and acquaintances. We trust the Government estimate is the correct one. The idea, in a general way, seems to be that some distinguishing badge or other mark of distinction be given to those men whose services are considered more valuable at home than in the ranks. This, by inference, will leave all the untagged in the eligible class. If this system is applied indiscriminately by a careful canvass and consideration of each individual citizen in Canada, it will doubtless prove effective, and is along the line of what we have all been hoping for from the beginning. If, on the other hand, it is to be applied only to those who offer themselves as recruits, it will fall short of the desired effect; for, while it may prevent men from going who ought to stay at home, it will lack entirely that moral effect which the absence of a badge would have in the former case.

The logical course, as we have urged from the beginning, is an inventory of the man-power of the Dominion, so that the standing and value of each citizen in this time of stress may be known. This would not only give the authorities an idea of the men who ought to be in the ranks, but it would enable them to place men of special training and ability in positions for which they are specially fitted. Of course, this scheme presupposes, for a few months, the subservience of political patronage to the common good — too much to expect, we fear, from any political party at the present stage of our civilization. How much more quickly this war would be brought to a happy ending if every citizen, for the time being, could just be fitted into that niche in our civil, political, and military life which he is best equipped, both by training and natural ability, to fill.

Selecting Rock Materials

MODERN construction work depends on and employs rock materials to such an extent that a better acquaintance with their characteristics and properties is desirable and, indeed, essential. Very little thought has been given, in general, to the investigation of the suitability of rock as a structural material. Contractors and engineers occasionally are lax in selecting and grading the stone which they employ in the fabrication of concrete, or in the building of highways. This is not, as a rule, a result of indifference, but is due, in part at least, to the lack of sufficient experience regarding the use and suitability of these materials and to the need of experimental data upon which to base the practical employment of rock or stone.

From time to time we have published in our editorial pages items bearing on this subject, and in this issue are reproducing extracts from a recently issued bulletin of the United States Department of Agriculture, in which are incorporated results of extensive tests and experiments performed on road-building rocks, to investigate their suitability for this purpose. This report points out that the success or failure of a road depends very largely on the manner in which the rock used in its make-up will resist the destructive and deteriorating influences of traffic. The ability of rock to withstand this type of wear is dependent almost wholly on its physical properties and in developing experimental means for investigating these attributes, especially in relation to the suitability as road-building materials, the United States Department of Agriculture is opening the way for a keener and more potent realization of the need of developing a more scientific method of selecting rock for construction purposes.

It is not, however, in highway engineering fields alone that a more careful selection of rock is essential. In the fabrication and manufacture of concrete of any description employing coarse aggregates a knowledge of this matter is requisite. Much discussion has been and is being directed in regard to the proper and most efficient aggregate. The introduction of concrete is of such recent date that there is very little basis of experience upon which to judge, and the matter remains

a more or less debatable and undecided subject. One must not overlook the fact that in the manufacture of concrete the cement in itself plays only a small part. The manufacture of cement is so clearly standardized and its properties so carefully specified and tested that it can be regarded as a material of unvarying and well-defined qualities. Not so with concrete, however. There are many considerations of a variable nature that cause the strength of concrete to vary within very wide limits, and one of the most important is the quality of the aggregate material. Certain facts in this regard have been determined by experience, but there is much to be learned that only actual laboratory tests can determine.

A chain is as strong as its weakest link, and in a structure the rock may be the important factor in determining the strength and durability. Whether so or not, we cannot fail to realize the importance of careful investigation and selection of so necessary a material.

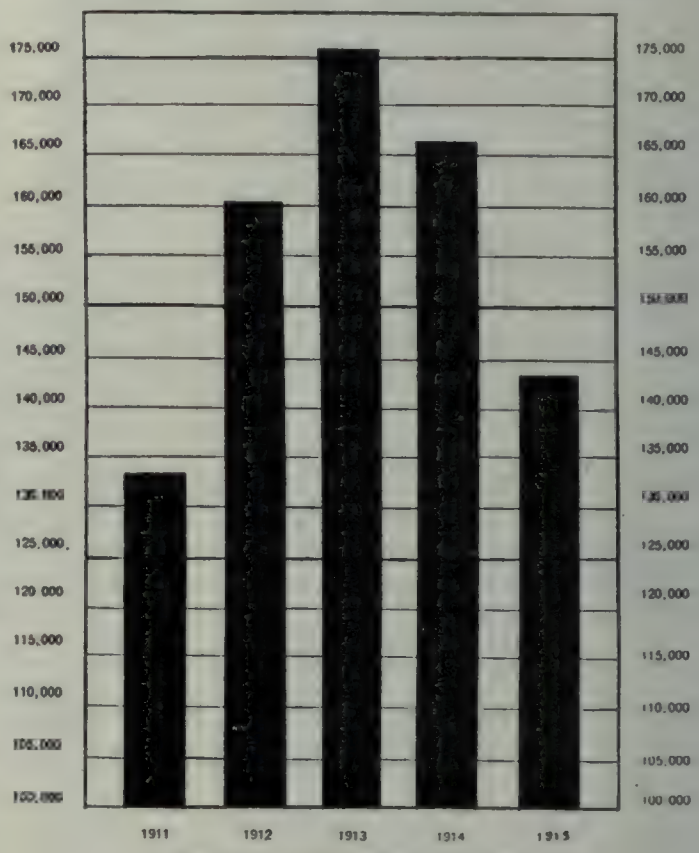
This subject presents an almost unlimited scope, for in addition to the physical properties, other more economic features, such as availability, cost, and local conditions, are important in so far as ultimate economy is concerned. Yet, aside from these, a more general application of laboratory experimenting in regard to rock materials cannot but lead to a more efficient standardization of constructional methods. Of course, much investigation is necessary to properly correlate laboratory tests with service results, but with a more defined meaning in regard to the availability and utility of stone or rock, a path is opened to better, more efficient, and more economical results.

Decline in Trade Union Membership

The Department of Labor, Ottawa, has just issued its fifth annual report on "Labor Organization in Canada." One of the most striking items in this report is the marked decrease in trade union membership. The causes of this decrease, as outlined in the introductory remarks, are: serious depression in certain lines, noticeably in the building trades, and the fact that a large number of union members enlisted; also the employment of Canadians in munition factories in Great Britain has taken a number of our men. Regarding these causes the report has the following explanation:

Recruiting not Solely Responsible for Decline in Membership

Not all the war recruits, however, by any means are to be counted out of the ranks of trade unionism, since more than one-half of the local branches which have sent members to the front are keeping the enlisted members in good standing. Probably arrangements were made in other such cases which will largely prevent a loss of membership on account of trade unionists thus temporarily out of Canada. The larger part of the membership decline must be therefore charged to other causes than recruiting, and will be found no doubt chiefly in the depression already mentioned, and which in the case of certain industries has now been continuous for several years. This is notably the case in the building trades group, where the losses in membership during the past year are placed approximately at ten thousand. All the other trade groups, with the exception of that embracing the various classes of railway employees, show decreases, though none in the same proportion as that of the building trades group. The loss in membership necessarily increases the war burden assumed by most of the locals as to payment of the per capita tax of the "soldier members," and since this must tend to increase with further recruiting, the outlook for organized labor is one which its officials may well view with considerable apprehension. Also an investigation would doubtless show a heavy decline in the natural increment to membership in local branches



Five years of trade unionism in Canada.

necessary to make good the customary losses from age, illness, changes of residence, death, etc. Such additions have been drawn naturally in the past largely from the ranks of incoming immigration, which has practically ceased, and from those of the younger craftsmen which have been heavily depleted by the extensive recruiting for the Overseas Forces.

General Use of Metric System

At a special business conference of the British Imperial Council of Commerce, held on June 6, 7, 8, 1916, under the presidency of the Right Honourable Lord Desborough, to consider a number of economic questions which require to be studied preparatory to the resumption of peace conditions, a number of important resolutions were adopted, including the following in regard to the general use of a universal decimal system:

That the British Imperial Council of Commerce be requested, by representation to the Imperial and Dominion Governments, and otherwise, to make every effort to bring about the adoption throughout the Empire of a uniform decimal system of weights, measures and currency, in order that trade relations with foreign countries may be developed and extended.

Wells & Gray, Limited, announce the removal of their Windsor office from No. 8 Royal Bank Building, to the Canadian Bank of Commerce Building, corner of Sandwich street and Ouellette avenue.

Physical Tests on Road Building Rocks

Results of Experiments on 3650 Samples—Valuable Information for the Roadways Engineer or Superintendent

HIGHWAY engineers will be specially interested in Bulletin No. 370, just issued by the United States Department of Agriculture, in which are published results of physical tests on a large number of road-building rock samples. Up to the present time tests have been made by this department on some 3,650 samples gathered from the United States and Canada. An appendix to the bulletin gives an itemized statement of each test. Extracts from this interesting report are given herewith.

Agencies Causing Road Deterioration.

Roads may deteriorate from both external and internal causes. The destructive agencies may be classified as mechanical, chemical, and physical, but in some respects it is more convenient to consider deterioration as being due to the effect of (1) traffic, (2) climatic conditions, and (3) faulty construction. The first two are external agencies and the latter is internal.

Traffic.—Traffic divides itself into two classes—(a) horse-drawn vehicles and (b) self-propelled or motor-driven vehicles. In the former the impact of horses' feet tends to disturb the position of individual fragments of rock in the wearing course and also to fracture the rock. At the same time wheels, especially steel-tired wheels, not only exert an abrasive action which grinds away the rock surfaces, but tend to crush the fragments of rock in proportion to the load per unit width of tire.

Automobile traffic exerts a severe shearing action upon the road surface, which tends to loosen the individual fragments and, ultimately, to remove them from the road. Where chains or armored tires are used, considerable abrasion may also result, especially under those conditions which favor slipping or skidding.

Climatic Agencies.—So far as the rock itself is concerned, climatic or weather conditions are not important destructive agencies. While it is true that rain and surface waters gradually dissolve or react with certain rock-forming minerals, the action is so slow as to be practically negligible as a source of deterioration during the life of a road. Frost may cause some deterioration in the more porous types of rock, but both rain and frost are more destructive to the road structure than to the rock of which it is built. Wind also is a negligible factor so far as the rock is concerned.

Faulty Construction. — Faulty construction may result in rapid deterioration of the road proper, due to a number of causes, such as poor drainage, lack of proper consolidation, the use of the wrong size or wrong grading of broken stone, etc. Destruction or disintegration of the fragments of rock may also be hastened by these errors in construction.

Factors Influencing the Selection of Rock for Road-Building.

In accordance with the preceding discussion, it is evident that from the standpoint of destructive agencies traffic conditions are the most important factors to be considered in the selection of rock for road-building. Availability as well as relative cost are also important factors in so far as ultimate economy is concerned, but need not be considered in this bulletin. In addition, the type of road to be constructed is a most important consideration; and, in general, the selection of rock should be based upon the character and volume of traffic as related to the type of road in which it is to be used.

The more common types of road in which stone is used are:

1. Water-bound broken-stone roads, as macadam, maintained as such.
2. Water-bound macadam roads maintained with dust palliatives.
3. Water-bound macadam roads with bituminous carpet.
4. Bituminous broken-stone roads with a seal coat of bituminous material constructed according to the penetration method.
5. Bituminous concrete roads with a seal coat of bituminous material.
6. Bituminous concrete roads without a seal coat of bituminous material.
7. Portland cement concrete roads, with a coarse aggregate of broken stone.
8. Stone-block pavements.

The destructive effect of traffic, both with respect to character and volume, varies to a considerable extent for the different types of road.

PHYSICAL PROPERTIES OF ROAD-BUILDING ROCK.

The success or failure of a rock for road-building depends largely upon the extent to which it will resist the destructive influences of traffic. The three most important physical properties are hardness, toughness, and binding power. Hardness is the resistance which the rock offers to the displacement of its surface particles by abrasion; toughness is the resistance which it offers to fracture under impact; and binding power is the ability which the dust from the rock possesses, or develops by contact with water, of binding the large rock fragments together. In order to approximate as closely as possible in the laboratory the destructive effects produced by the various agencies which have been mentioned, certain physical tests have been developed. Brief descriptions of these tests are as follows:

Hardness Test.

Hardness is determined by subjecting a cylindrical rock core 25 mm. in diameter, drilled from the specimen to be examined, to the abrasive action of quartz sand fed upon a revolving steel disk. The end of the specimen is worn away in inverse ratio to its hardness, and the amount of loss is expressed in the form of a coefficient as follows:

Coefficient of hardness=20—1/3 w, where w equals the loss in weight after 1,000 revolutions of the disk.

Toughness Test.

Toughness is determined by subjecting a cylindrical test specimen 25 by 25 millimeters (1 by 1 inch) in size to the impact produced by the fall of a 2-kilogram (4.4-pound) hammer upon a steel plunger whose lower end is spherical and rests upon the test piece. The energy of the blow delivered is increased by increasing the height of fall of the hammer 1 centimeter (0.39 inch) after each blow. The

height of blow in centimeters at failure of the specimen is called the toughness.

Deval Abrasion Test.

A test devised by the French for measuring the combined action of abrasion and impact is as follows: Five kilograms (11 pounds) of freshly broken rock between 2 and 2½ inches in size is tested in a special form of cylinder, so mounted on a frame that the axis of rotation of the cylinder is inclined at an angle of 30 degrees with the axis of the cylinder itself. The fragments of rock forming the charge are thus thrown from end to end twice during each revolution, causing them to strike and rub against each other and the sides of the cylinder. After 10,000 revolutions the resulting material is screened through a 1/16-inch sieve, and the weight of the material passing is used to calculate the per cent. of wear. The French coefficient of wear is calculated from the per cent. of wear as follows:

$$\text{French coefficient of wear} = \frac{40}{\text{Per cent wear.}}$$

Cementing-Value Test.

To determine the binding power, or cementing value, as it is usually called, 500 grams (1.1 pounds) of the material to be tested is crushed to pea size and ground with water in a ball mill until it has the consistency of a stiff dough. It is then moulded into cylindrical briquettes 25 by 25 millimeters (1 by 1 inch) in size, which, after thorough drying, are tested to destruction in a special form of impact machine. A 1-kilogram (2.2-pound) hammer falls through a constant height of 1 centimeter (0.39 inch) upon an intervening plunger, which in turn rests upon the test piece. By means of a suitable arrangement a graphic record of the number of blows required to destroy the specimen is obtained. The number of blows producing failure is called the cementing value of the material.

Specific Gravity—Weight Per Cubic Foot—Water Absorption.

The specific gravity, weight per cubic feet, and the water absorption in pounds per cubic foot are obtained on samples of rock which are tested to determine their road-building qualities. The weight per cubic feet is calculated from the specific gravity of the material obtained on a 10-gram sample by the usual displacement method. The gain in weight of this fragment, after four days' continuous immersion in water, is used to calculate the water absorption in pounds per cubic foot of the solid rock.

VARIATIONS IN RESULTS OF TESTS.

Because of the fact that the various rock families, when subjected to the tests outlined above, give results which are more or less distinctive of a group or type, these results can best be discussed in many cases collectively. There are 14 families of rock which are more or less commonly used in macadam-road construction.

Trap-Rock Group.

The first six rock families—Andesite, Basalt, Diabase, Diorite, Gabbro, and Rhyolite — comprise the well-known group of road-building rocks commonly known as "trap." They are all of igneous origin, but are denser and finer grained than the granites, possessing as a rule a peculiar interlocking crystalline structure which imparts to them their distinguishing characteristic—high toughness. The average toughness of all the traps, with the exception of gabbro, which runs somewhat lower, is about 18. This is a considerably higher average than that shown by any of the other types or groups. The same relationship holds true in the abrasion test, the average French coefficient of wear running from about 13 to 15. Comparatively slight variations in hardness are noted for any family or for the group as a whole, the average hardness for which is about 18. The binding power of the traps, as determined by test, varies through wide limits, depending largely on the degree of weathering they have undergone. The specific gravity of this group averages about 2.9, giving an average weight per cubic foot of 180 pounds. Individual samples are seldom less than 2.7 nor more than 3.2 specific gravity. Water absorption may vary from a few hundredths of 1 per cent. to over 7 per cent.

Granites.

Granite, the typical rather coarse-grained igneous rock, is characterized by low toughness and high hardness. The average value for the former is about 8, while that for the latter runs as high as for the trap group, about 18.5. The abrasion test develops an average French coefficient of wear of about 11, somewhat lower than for the trap-rock group. Cementing values made on granites run low, as has been demonstrated by experience, the only exceptions being very highly weathered material which usually shows low toughness and resistance to wear. The specific gravity of the granites averages close to 2.7, and is seldom less than 2.6 or more than 2.8. The weight per cubic foot, therefore, averages 168 pounds, and may ordinarily vary from 163 to 175 pounds. Water absorption has been found to run from about 0.04 to 3 per cent.

Limestones and Dolomites.

The limestones and dolomites, or magnesium limestones, are undoubtedly the most widely used road-building rock. They run much lower in hardness, toughness, and resistance to wear than do the traps or granites. The average French coefficient of wear is about 8, toughness 7, and hardness 15. The cementing values are usually good, about 75 per cent. of all samples tested running over 25. The specific gravity of the limestones and dolomites averages close to 2.7, about that of the granites, and is seldom less than 2.6 or more than 2.85. In general, the weight per cubic foot will run from 160 to 178 pounds, with an average of about 168 pounds for the limestones and 170 pounds for the dolomite. Absorption may vary from a few hundredths of 1 per cent. to over 13 per cent.

Sandstones.

The sandstones are characterized by wide variations in the results of all tests. In fact, the highest and lowest values obtained for all samples tested have, with one exception, been upon sandstone. The average French coefficient of wear is about 12, average toughness about 10, and average hardness about 16. The cementing value of sandstones varies widely, depending upon their composition. Thus certain varieties of feldspathic sandstone somewhat resembling trap rock in appearance almost invariably show high binding value in the laboratory. Their specific gravity also varies between wide limits, but usually lies between 2.4 and 2.8, with an average of 2.62. The weight per cubic foot therefore varies from 150 to 175 pounds and averages 164 pounds. Absorption runs from a few hundredths of 1 per cent. to about 2 per cent.

Marble and Quartzite.

Marble and quartzite are the two families of non-foliated metamorphic rocks corresponding to limestone and sandstone respectively. While in some respects it is convenient to consider marble with the limestone and dolomite group, the average toughness of marble, about 5, is lower, and the average hardness, which is

less than 14, is also somewhat lower. Marbles usually show good cementing value tests with about the same range as the limestones and dolomites. For those samples tested, the specific gravity ordinarily falls between 2.7 and 2.9, and the weight per cubic foot averages 173 pounds, which is somewhat higher than the average for either limestone or dolomite. As would, therefore, be expected, the maximum absorption is less, being under 2.5 per cent.

Quartzites show an average toughness of 15, as compared with 10 for the sandstones. The coefficient of hardness is also higher and, for the samples tested, shows a much smaller range of values than for the sandstones. The quartzites invariably show a low cementing value. The specific gravity from tests made usually lies between 2.6 and 2.8, and their average weight per cubic foot is about 167 pounds. Their water absorption runs from a few hundredths of 1 per cent. to nearly 3 per cent.

Gneiss and Schist.

Both gneiss and schist belong to the foliated metamorphic type of rocks. The former is in reality a metamorphosed granite, and, therefore, shows physical properties similar to the granites. The average French coefficient of wear for the gneiss samples is about 9, being somewhat lower than for the granites, while their average hardness and toughness is about the same. Their specific gravity, weight per cubic foot, and absorption are approximately the same as for granite.

The schists show an average French coefficient of wear of about 12. Their average hardness is about 17.5, and their toughness averages 11, the latter being higher than for gneiss. It should be noted, however, that the toughness test for both gneiss and schist is made perpendidcular to the plane of foliation. If taken horizontal to the plane of foliation much lower results would be obtained, as failure would then occur along these natural lines of cleavage. The specific gravity of schists usually lies between 2.65 and 2.90, and the average weight per cubic foot is about 181 pounds. Water absorption is seldom over 2 per cent. for this family.

With the exception of the highly altered varieties, both gneisses and schists show a rather low cementing value.

Chert.

Chert is a very hard material, but frequently shows a low resistance to wear, owing to its tendency to fracture along lines which have developed as shrinkage cracks in the rock structure. For this reason it is extremely difficult to test for toughness. The cementing value of pure chert is usually low, but some highly weathered deposits develop in service good cementing value, especially if a high-binding clay is associated with it. Comparatively few samples which have been submitted for examination have been found suitable for all tests. Of those examined, however, the French coefficient of wear has usually been found to lie between 2 and 8, with an average of 5; toughness between 7 and 26, with an average of 16; and the hardness coefficient between 19 and 20. Specific gravity usually lies between 2.4 and 2.65, and the average weight per cubic foot is about 160 pounds. Water absorption may run from a few tenths of 1 per cent. to over 8 per cent.

Shale and Slate.

Shales and slates are highly laminated rocks that tend to break into flat plates not suitable for road-building purposes. They are seldom used in road construction, except perhaps as a filling for sub-foundations. They vary greatly in nearly all of their physical properties.

Rare Road-Building Rocks.

A comparatively few samples of a number of families of rocks which are occasionally used in road-building have been examined in the laboratories of the United States Office of Public Roads and Rural Engineering. They need not be considered in detail, but the usual ranges, as well as the averages of results of the more important physical tests of these rocks, are given in Table I.

TABLE I.—*The rare road-building rocks.*

Number of samples.	Name.	French coefficient of wear.		Toughness.		Hardness.	
		Ordinary range.	Average.	Ordinary range.	Average.	Ordinary range.	Average.
20	Amphibolite	11.3–26.7	16.7	12–40	19	16.6–19.0	17.5
10	Eclogite	12.7–22.7	16.1	14–28	26	18.6–19.1	18.5
12	Epidosite	10.0–18.7	13.0	10–23	16	17.6–19.5	18.0
11	Felsite	11.9–21.3	15.8	.....	16	.	19.2
6	Peridotite	7.6–13.2	10.3	9–12	10	13.3–16.6	15.0
8	Serpentine	2.6–14.2	10.1	11–21	14	18.3–18.6	18.4
5	Trachyte	11.5–23.5	16.2	21–34	22	17.7–19.1	18.1
19	Syenite	7.0–18.7	13.1	8–22	14	17.3–19.2	18.1

Slags.

Many slag varieties resemble in certain outward respects the common road-building rocks. However, in general, they are more porous and glassy, and vary so greatly in physical properties that with reference to their physical characteristics from the standpoint of road construction they cannot well be considered as a single class, with definite limits or general average numerical values.

INTERPRETATIONS OF RESULTS OF PHYSICAL TESTS.

The results of physical tests are only of value in predetermining the suitability of a rock for a given type of road under given conditions when the behavior of other rocks having the same general physical characteristics is known. Much investigation is still necessary to accurately correlate laboratory tests with service results, but in this connection certain facts have been determined from experience, which may be briefly discussed under the different types of roads.

As the amount of traffic to which a road is or will be subjected is a most important consideration, and as the terms light, moderate, and heavy are commonly used in describing the amount of traffic, such terms should be defined. For the purpose of comparison it has been assumed that traffic of less than 100 vehicles per day is light, between 100 and 250 moderate, and over 250 heavy.

Water-Bound Macadam Roads.

The ideal rock for the construction of a water-bound macadam road resists the wear of traffic to which it is subjected to just that extent which will supply a sufficient amount of cementitious rock dust to bind or hold the larger fragments in place. It is generally admitted that the ordinary macadam road is not well suited to any considerable amount of automobile traffic, because such traffic rapidly removes the binder without producing fresh material to take its place.

Cementing value is a necessary quality for rocks used in macadam road construction. As determined by test, cementing values below 25 are called low; from 26 to 75 average, and above 75 high. In general, the cementing value should run above 25. For rocks which show a low French coefficient of wear, however,

a relatively high cementing value is more necessary than for those which have a high French coefficient. Interpretation of results of the cementing value test is subject to a number of influencing considerations. For instance, it has been found that certain feldspathic varieties of sandstone give excellent results in this test, while experience has shown that they do not bind well when used in the wearing course of macadam roads. In the case also of certain varieties of the trap group low results are frequently shown by laboratory tests for rocks which bind quite satisfactorily upon the road, provided traffic is sufficiently heavy to supply the requisite amount of fine material. Certain granites, gneisses, and schists which are not suitable for use as binding material give good results in this test. In such cases it is usually found that the highly altered nature of the material reduces its toughness and resistance to wear to such an extent as to condemn it for use.

Experience has shown that, in general, the following table (Table II.) of limiting values for the French coefficient of wear, toughness, and hardness may be used in determining the suitability of a rock for the construction of the wearing course of a macadam road.

TABLE II.—*Limiting values of physical tests of rock for water-bound macadam road construction.*

Character of traffic.	Limits of tests.		
	French coefficient of wear.	Toughness.	Hardness.
Light	5–8=(5–8 per cent wear)	5–9	10–17
Moderate	8–15=(2.7–5 per cent wear)	10–18	Over 14
Heavy	Over 15=(less than 2.7 per cent wear)	Over 18	Over 17

With relation to the limitations for hardness, it may be noted that as a result of comparing hardness and toughness tests of some 3,000 samples, the authors have shown that when any given value for toughness falls within certain limits which define the suitability of the material for macadam road construction under given traffic conditions, the corresponding value for hardness will fall within similar limits for hardness. In this connection it will be seen, in Table II., that a maximum limit for hardness is only given in the case of light traffic. It has been found that the great majority of samples having a French coefficient of wear of from 5 to 8 and a hardness of over 17 are granites, quartzites, and hard sandstones, which are unsuited for use in the wearing course of water-bound macadam roads due to their lack of binding power.

Bituminous Roads.

For broken-stone roads which are maintained with dust palliatives, the same limits for French coefficient of wear and toughness should hold as for ordinary macadam roads.

In bituminous work observations indicate that in some cases it is advantageous to use a rock of relatively high absorption rather than one with low absorptive qualities, owing to a better adhesion of the bituminous material by a partial surface impregnation of the rock.

While the binding or cementing value of a rock is a most important consideration from the standpoint of ordinary macadam construction, the same is not true of broken-stone roads which are carpeted or constructed with an adhesive bituminous material. The French coefficient of wear is also of relatively less importance, owing to the fact that the fine mineral particles produced by the abrasion of traffic combine, or should combine, with the bituminous material to form a mastic, which is held in place and protects the underlying rock from abrasion so long as by proper maintenance it is kept intact. The toughness of the rock is of more importance, as the shock of impact is to a considerable extent transmitted through the seal coat and may cause the underlying fragments to shatter. It would, therefore, seem that the minimum toughness of a rock for use in the construction of a bituminous broken-stone road or a broken-stone road with a bituminous-mat surface should, for light traffic, be no less than for ordinary macadam subjected to the same class of traffic. For moderate and heavy traffic, however, the same minimum toughness should prove sufficient, owing to the cushioning effect of the bituminous matrix. No maximum limit of toughness need be considered for any traffic.

In the case of bituminous concrete roads, where the broken stone and bituminous material are mixed prior to laying and consolidation, it generally appears advisable to set a minimum toughness of 6 or 7 for light-traffic roads, instead of 5, in order to insure that the fragments of rock which have been coated with bitumen shall not be fractured under the roller during consolidation; and 12 or 13 for moderate and heavy traffic, instead of 10 and 19, as in the case of water-bound macadam roads.

Bearing in mind the fact that availability, cost, and various local conditions may often modify the selection of proper limits, Table III. may be used as a general guide for minimum limits of French coefficient of wear and toughness in connection with bituminous broken-stone roads.

TABLE III.—*Minimum limits of physical tests of rock for bituminous-road construction.*

Type of road.	Light to moderate traffic.		Moderate to heavy traffic	
	French coefficient of wear.	Toughness.	French coefficient of wear.	Toughness
Broken stone with bituminous carpet. Bituminous broken stone with seal coat.	6=(not over 8 per cent wear).	·5	7=(not over 5.7 per cent wear).	10
Bituminous concrete with or without seal coat.	7=(not over 5.7 per cent wear).	7	10=(not over 4 per cent wear).	13

Portland Cement Concrete and Stone Block.

The most desirable limitations for broken stone to be used as coarse aggregate in Portland cement concrete wearing surfaces have not as yet been ascertained. In general, however, it would seem that the low limit for hardness should be no less than the hardness of the mortar which binds the rock fragments together. At the present time a minimum hardness of 12 for moderate and 16 for heavy traffic would appear reasonable. In consideration of the type of traffic to which concrete roads are subjected, a minimum toughness of 8 is suggested.

Stone blocks are usually manufactured from granite or sandstone, although other rocks may also be used. Specifications for granite block adopted in 1914 by the American Society of Municipal Improvement call for a toughness of not less than 9 and a crushing strength of not less than 20,000 pounds per square inch. It would appear wise to also require that the hardness be not less than 16.

Awarded Contract for Steel

The Burlington Steel Company, Ltd., Hamilton, have been awarded the contract for reinforcing steel for the new Goodyear Tire and Rubber Company building at Toronto.

The Wonderful Mystery of the British Navy

IN a recent issue of the Contract Record we printed an article from the British "Engineer" outlining some interesting and encouraging facts in connection with the recent Jutland battle. Since that date a representative of the "Engineer" has been permitted to view with his own eyes some of the operations of the British navy yard, and describes his impression in guarded language, without disclosing, of course, any information that may be of value to our enemies. We in Canada who trust blindly and implicitly to the British navy cannot be other than deeply gratified that our confidence is fully shared by one who has seen. According to this article, which follows, we have little conception of the developments of the past two years in a navy which at the beginning of the war was justly considered invincible:

If there is one thing more than another about which the peoples of the British Empire desire to know everything it is that great navy which now holds undisputed sovereignty of the seven seas. What their armies are to other European powers the navy is to Britain. Her army—her national army—is not two years old, it has no past, and is only beginning to make glorious traditions. Her navy goes back to the very beginnings of her history; it is the foundation of her strength, the rock on which the Empire is built, the one thing that binds the heterogeneous parts together and welds them into a solid whole. Small wonder that the British people crave for news of it. But so do our enemies. They also desire to know what our latest battleships are like, what guns our cruisers mount, and what speed they attain, what developments have taken place in the design of submarines, how many destroyers are built a month, and what new excellencies they show. They also want to know how the battle-scarred fleet fares, how ships suffered, and how they were made fit again for sea. They also would like to learn why certain things that they did not by any means anticipate happened. Why ships they thought they had disabled were able to come back safely to port under their own steam; why a torpedo fired by the Moresby found its billet in a German hull eight minutes later. About all these things and many more they desire greater knowledge, and it is just for that reason and for no other that nothing can be said about them.

We wish it were otherwise. Through the courtesy of the Admiralty we have been permitted to see something of what is being done in our great dockyards and to visit some of our latest ships. We wish with all our hearts we might write it all down for our readers. There is a certain class of people who persistently refuse confidence to their own country; who are greedy enough for all wonders circulated by the enemy for his own glorification; who grasp at such small events as the voyage of a submarine from Germany to America; who are willing to believe rumors about marvellous new weapons fitted by Germans on impossible ships and yet will not credit Britain with the resourcefulness, the ingenuity, and the energy to introduce a single new thing. If only these men of little faith could be taken to the shipyards we visited and see the ships we saw; if only they could talk to the officers and assimilate some of their cheery confidence, their trust and pride in their guns and vessels, their optimism and their longing once more, at least, to meet the enemy in fair fight, even they would be driven from the pessimistic attitude; even they would be forced to admit that the British navy is something to wonder at, something never to doubt, something to be very proud of and to trust implicitly through thick and thin. We spoke with one officer about the first report of the Battle of Jutland, that report which has been so widely condemned. He had not a word to say against it; the men who had fought the action were quite satisfied with it. It was the public that did not understand. The navy knew it had to lose ships—that was part of the day's work, the price of sea power. It was not a bit disturbed by the loss, for it had done what it went out to do, and that was all that mattered. And it is ready to go out and do the same thing again on the same terms. We have heard of the battering some of our ships received. Take, for example, the Warspite, which, it will be recalled, through a mishap to her steering gear, turned towards the enemy's line and was so severely handled that the Germans believed, not without some reason, that she had been sunk. We have seen her now with our own eyes, holding her place in the line of great ships, ready for action at a moment's notice, and the only evidence of the fight a few barely distinguishable patches here and there. Yet when we saw her it was barely six weeks since the Battle of Jutland, and she had already been some time back with her squadron. It is almost inconceivable the rapidity with which vessels had been got ready again for sea. One great ship had refilled with oil and ammunition and was under steam again twelve hours after the action, and she practically gave the time for all the lesser craft; all save those that needed much repair were ready next day again to meet the enemy. We wish the public could see them. Line after line of grey ships of all sizes, grouped more or less according to their classes, and a little further off a second fleet, this time the auxiliaries, oilers, and colliers and repair ships, the handmaids of the navy, waiting there patiently to do whatever drudgery must be done. A very kind thought must be given to the officers and men of these vessels. Then, too, we wish the public could see the dockyards and gain some impression of the well-ordered haste with which ships of all kinds and sizes are being built; new vessels of huge size and swifter by far than anything of their class afloat, destroyers packed together on the berths so close that the central framing of some cannot be built till the adjacent vessels have been launched; monitors of strange form, with special protection against torpedoes, mine-layers, and mine-sweepers, vedette boats, patrol boats, and last, but not least, submarines of a new class that leave all others far behind. There is continual progress, not only in the rate of output of individual ships, which in some cases has been more than doubled, but in the design. Every action brings its own lessons, and they are quickly acquired and as quickly put into practice. Everyone remembers the mishap to the Lion when Admiral Beatty chased the Germans across the North Sea. No one thought of such an accident happening; but steps have been taken to prevent it ever occurring again, even in comparatively elderly ships. Much knowledge has been acquired about armouring and about bulkheads, and is being applied as quickly and effectively as may be. And so on all through; every scrap of experience is carefully studied and turned to account.

Our confidence in the officers and men and ships of the British navy, and in the masters and men and

equipment of British shipyards has never wavered, but we have returned from our visit with it multiplied again and again. We must not yet say how many new vessels have been built since the war began, but we may say that it almost passes belief. Owners of engineering factories have told us that had anyone asked them three years ago what was the greatest output they could attain they would have given figures a hundred per cent. or more below the mark. The same may be said of our shipyards. By the careful utilization of labor, by proper addition to plant of all kinds, and by never-ceasing work they have succeeded in putting an enormous number of vessels into the water. Twenty months ago the designs of two great ships we saw were only being talked about. Now those two vessels are nearing completion. And, be it remembered, we are writing of one district only. The same activity is going on in others, both in royal and private yards. At the same time all the things that ships need to maintain or equip them for their duties are being finished months, even years, before their time; factories are being erected, cranes built, berths lengthened or made and machine tools purchased by hundreds. Let whoever doubts ponder these things; let him, if he can, see something of them, and he will be forced to admit that the British navy of to-day is much greater than before, much stronger, much better, and that the shipbuilding resources of the country have preserved through the years a vitality and an elasticity which gives them easily the first position in the world. We wish we might be more precise, that we might give facts and figures, but as that is impossible we only ask our readers to share with us a confidence which has been doubled and trebled by an inspection of our yards and ships.

Year Book of Ottawa Branch, C.S.C.E.

The Ottawa branch of the Canadian Society of Civil Engineers are taking steps to keep the address list of their members up to date. To this end they have prepared a branch year book, which they are sending out to their members, containing a list of the membership as shown by present records. Members of this branch are requested to advise the secretary promptly (1) of any members who have enlisted for overseas whose names are not so indicated in the book; (2) the names of any engineers not included in the list and located within the 25-mile limit; (3) the names of any engineers on the list who are not now within this limit. A blank form is also enclosed, so that each member's address may be brought up to date.

There is being distributed to the members of the Ottawa branch a copy of a general notice recently issued by the honorary secretary of the Civic Improvement League. Quite recently the chairman and secretary of the Ottawa branch were invited to attend organization meetings of this league in Ottawa, the objects of which are to promote the highest interest of the city of Ottawa; to stimulate the study of processes and methods of civic improvement and development; and to secure a general and effective interest in affairs pertaining to the welfare of the citizens. The League has elected an executive committee, and while the work of organization is being completed an energetic sub-committee of ladies has undertaken to gather data concerning garbage collection, removal, and disposal. Another sub-committee is at work on the question of proper tree trimming. The committee is also in personal touch with the Mayor and Board of Control regarding the early establishment of an industrial farm, where social delinquents may be improved in body and mind instead of punished and further degraded by confinement in prison. Much other work will be undertaken shortly.

The League asks the good-will and hearty co-operation of everybody in Ottawa. In the letter sent out by the Ottawa branch of the C.S.C.E., signed by Mr. John Murphy, chairman, and Mr. J. B. Challies, secretary, it is pointed out that "engineers more than any others should be anxious to take part in and support the good work of the Civic Improvement League. It is, therefore, urgently desired that as many of the Ottawa branch of the Canadian Society of Civil Engineers as possible should join the League and actively take part in its work."

The permanent buildings at the Canadian National Exhibition cost over $2,500,000.

Rapid Building Construction

The illustration herewith shows a new plant just completed by Grant & Horne, engineers and contractors, St. John, N. B., for Messrs. McAvity & Sons. The machine shop was completed nine weeks from the date on which the contract was received, and the boiler house, which was increased in size after the building was under way, was completed two weeks later. The majority of the machinery is now installed in the buildings and running temporarily with power obtained from the street railway company. A small generating plant is, however, being installed for the McAvity company.

McAvity Machine Shop, St. John, N.B.—Completed in Nine Weeks.

A Parable in Graphics

"WILLIAM, I have a new stunt f'r ye," was the greeting Scotty Ross hurled at his partner, Billy Ballou, one sweltering, hot morning in July as the latter was taking off his coat and rolling up his shirt sleeves, preparatory to starting a session with a thick roll of blue prints, from which he had to make up an estimate.

"What is it, Scotty? A self-feeding concrete mixer that collects the price of its own work, or forms which place and strip themselves? I'll bet some machinery salesman has been playing you for a sucker so early in the morning," was Bill's reply.

"Ye mind the young feller that was up here from Ottawa f'r the Water Power Branch, don't ye? The one that was always tellin' us that efficiency methods should be applied to contractin'? Well, he's back here again to gauge Bull Creek for the Government, and dropped into the shack here yesterday afternoon to smoke a pipe with me and treat me to a little more hot air. He has a new hobby now. 'Tis 'graphics'. Accordin' to him, ye can do anythin' by this graphics business, and, sure, I believe there's somethin' in it for us at that," continued Scotty.

"Wait a minute! You're going too fast for my infant mind!" cried Billy. "You and I have been in the contracting game for ten years now, and in that time we have spent a good deal of money, for which we got precious little return. If there is really anything of value to us in this graphics business, I'm willing to look into it, but I must get this estimate for the L. M. and H. retaining walls done by to-night or we will not be able to get a bid in on time. What is graphics, anyway?"

"Listen to me, boy! Graphics is a sort of way of doin' a lot of your figurin' by means of lines on bits of paper. Accordin' to the young lad, there's little ye can't do by it; but I'm thinkin' that he's a bit daft on the subject," Scotty went on. "However, while he was here I got him to explain it to me as well as he could, and, for an example, he took those very same retainin' walls you was just kickin' about.

"Look here," he continued, producing a diagram like that of Figure 1, "ye'll note that all your walls are 18 inches wide on the top and that they all have the same batters on the back and face. Now, to get the yardage of concrete in them, ye have to take each height by itself and figger them out, and you're no wizard at figgers, me boy, though you're a lot better in that respect than I am, for ye have the advantage of a few years' schoolin', while I have none. Look at this pretty curve. On the left ye see a line of figgers marked 'Height of wall=H,' and at the bottom another row, marked 'Cubic yards per lin. ft. of wall.' Very well! Now, suppose we say, for the sake of tryin' the thing, that ye have a wall which is 20 feet high. Find '20' at the left, and then run acrost until ye hit the curve, and then down to the bottom, where ye land at about 3, or maybe 2.95, which means that in a foot of this wall there is 2.95 cubic yards of concrete. If your wall is 200 feet long, then the whole quantity of concrete is 200 x 2.95, or 590 cubic yards. Simple, ain't it?"

"It surely is simple, Scotty, but I could get it closer by the old way of figuring," answered Billy.

"Ye don't need to get it any closer than ye can this way," replied Scotty, "and, besides, if ye want to be more accurate, just make your diagram larger, that's all. However, 'tis near enough for us to use in an estimate anyway."

"Give me that sheet! I'll use it right now on these walls, since your young lad was good enough to make it up for us," said Billy.

"Hold up, boy!" answered Scotty. "Your lesson ain't done yet. Ye'll mind that you and me have had a bet on the time that we will finish the Hydro job? Well, I was talkin' to the young lad about that, and he says that is easy. He drawed me this one for that," producing the diagram shown in Figure 2. "When we took holt there there was a hundred yards of concrete placed by the other feller. Ye'll find all that up and down the left-hand side. We have until November 5th to finish the work, and there is 1,300 yards in all to put in. Look at any date ye like along the bottom, and if ye go up to the straight line ye'll find how many yards should be done then to keep up to the schedule. F'r instance, on September 3rd we should have 700 yards in. If we have not, we are behind the game.

"There's a lot ye can tell from this diagram. The line with all the white spots on it the young lad put in to show me how I was to keep me own records. Suppose that it's right, and that on the 3rd of September ye ask me how is the job goin' and are we goin' to finish on time or ahead or behind, and how much. I look at this thing and I draw the line AB, which goes through the point A and the one behind it, and I say to you, 'Sure boy! We are ahead of the game, for the point A is above the line of required progress, and if

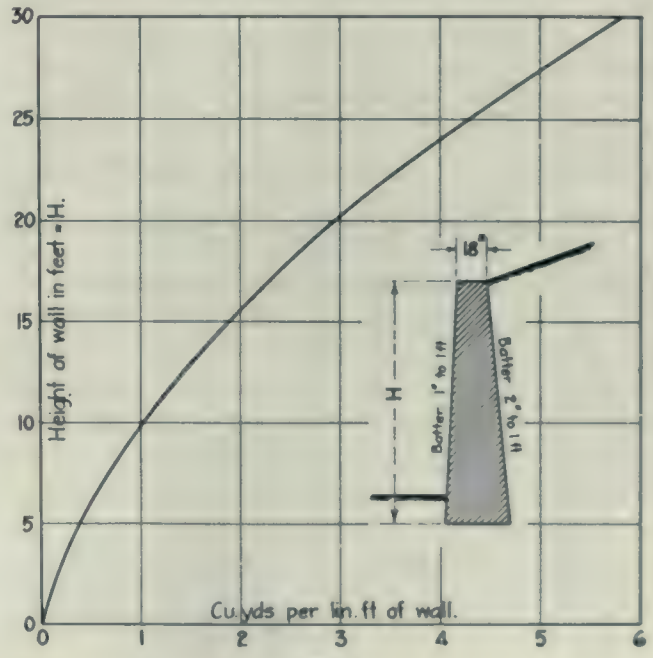


Fig. 1

we can keep it up at this rate we are goin' to finish about September 15th, which is over seven weeks ahead of contract time.' Suppose on the 10th you ask me again how goes it. I look at me curve and I say: 'We are still ahead of our time, but we are losin' ground, for I find that CE is more slantin' to the right than AB, and we are likely to finish about October 3rd at this rate, but if we can speed things up to the rate of last week we will be done on September 19th, for I have drawed CD so that it makes the same slope as AB, and I find it hits the 1,300-yard line on the 19th.'"

"By cricky, Scotty! I think that this graphics is going to be some help to us!" exclaimed Billy. "I sup-

pose we are as progressive as any small contractors placed as we are, where we have to do all kinds of work to make a living, but there are sure some things that the college boys can teach us, if we are willing to learn. The next time you see the young lad ask him for some more dope on the subject. In the meantime I will try to think of other applications of this method in our business. I am sure that there are a hundred

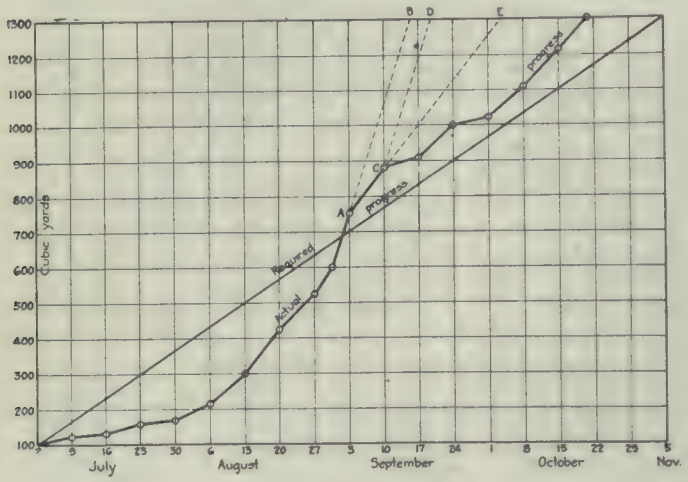


Fig. 2

places where it would be useful. Also ask him about the slide rule. I know he uses one, and I have seen a good many other engineers use them, but always thought they were too complicated for us. However, they may be some good."

"About the slide rule I know nothin' at all," replied Scotty, "but I do not believe in keepin' a young man from his legitimate amusements, so I'll be goin' out to the job."

Letters to the Editor

Bids, Bidders, and Bidding.

Editor Contract Record:

I have been very much interested in reading the articles that have been appearing in your valued publication on this subject, but surprised to see that very few people realize that conditions which are very often not warranted by the result place the contractor of modest means at a serious disadvantage.

It seems rather a peculiar state of affairs that a large percentage of the work in the West (with which a reliable and trustworthy contractor would care to have his name connected) goes to Eastern architects, thereby placing the Western contractor where he does not get a look in, and leaving neither himself nor the Western architect any other alternative than to get into the game of chance, which the most laudable business on the face of the earth, viz., the building up of the country, has now become; and this is through our catering to the people who now so freely advise us.

It has never appeared quite clear to the writer why it was necessary to have a Montreal architect and a New York contractor on the MacDonald Hotel or the Arts Building at Edmonton, for example, or why it was necessary to go to Chicago to get brains enough to build the Simpson building at Regina, or why go to England for a designer for the Manitoba lawsuit.

Is it any wonder that the Western architect and contractor should display a little energy and perhaps indulge in liberties at which they themselves would blush, only they feel they must do it or be starved out of business?

We pride ourselves much these times about our patriotism, and if there is any virtue in the accepted saying, "Charity begins at home," it is doubly true in our duty to ourselves, in the building up of a country endowed with so rich a heritage.

What would be the result if the good people of Regina, or possibly Saskatchewan, were to tell the Simpson Company to go to Chicago to get customers for their wares? But they know there is not the remotest chance of such a thing taking place. They are banking on the credulity of the public, and are sure to win out.

The situation of the sub-contractor would be very much different were he differently placed. He invariably has to solicit his business from people who have the price fixed, and whatever they can succeed in talking the sub out of, below that fixed price, is clear gain to the contractor. Conditions in general, from such master undertakings as the Panama Canal to the corner grocery, would be vastly improved if we could be favored with less advice from higher up, and society would greatly improve by allowing the rank and file the privilege of occasionally using their own grey matter.

The writer is, in a measure, familiar with building conditions in a great many places on this continent; also the customs of different localities; and I am forced to the conclusion that the situation in which a building contractor finds himself and the business (in which he is seeking to engage himself) has not been brought about altogether by his own doing, but has been largely the result of the interference of owners who may be grocers, tailors, preachers, or lawyers, each one of whom may be an expert in his line. Knowing nothing of building construction whatever, but being connected with a building project, they have advice galore to hand to the builder, who is unfortunately placed where he has to meet their demands, knowing at the same time they are impracticable, and when it comes settling-up time he finds himself very much the second party in the transaction.

The contracting business has also materially suffered through the introduction of the correspondence school variety of clerks. I don't know of anything more exasperating than to go into an office and have to do business with a man who does not know whether a brick should be round or square if he has not seen it in the book, and should he be asked the difference in price in laying brick on the first storey and the tenth he is helpless. He is very likely to reply: "We figured the brick at a certain price per M throughout." Here, again, is where the sub-contractor suffers. The money it takes to support this useless cub of a clerk must be made out of the sub, regardless.

Systems may come and systems may go, but the building contracting business will remain what it has become until people are brought to realize that it will not stand (and survive) any more meddlesome inexperience than any other business or profession.

Yours very truly.

A Western Building Inspector.

August 1, 1916.

Contracts were recently awarded by Vermillion County, Illinois, for the longest mileage of concrete roads ever let—145 miles. A bond issue of one and a half million dollars has been made to cover the cost of these roads.

A General Discussion of the Extent to which Sewage can be Purified by Methods of Artificial Treatment Now in Use

(Continued from August 16 issue.)

The Trickling Filter System

The oxidizing power of all bacterial agencies depends upon an ample supply of atmospheric oxygen. This must be absorbed by the bacterial jelly of the contact bed, mainly during the rest period which is limited to a fraction of the operating cycle, rarely exceeding three-quarters of it. The quantitative efficiency of the contact bed is low also, because of its limited capacity for the storage of sewage in contact with the bacterial surfaces. These limitations have led to efforts to devise beds which would accomplish similar work without being subject to such restrictions. The most important derivative of the contact bed is the trickling filter.

Like the contact bed, this filter is composed of coarse grained particles, the most popular size at present perhaps being 1½ in. in longest dimension. The thickness of the beds varies from 5 to 10 feet, and their shape depends upon the method of distribution or local conditions of controlling importance. The stone is placed upon concrete or vitrified tile draining floors. The sewage is distributed as uniformly as may be over the surface of the bed, by revolving arm sprinklers, distributors moving backward and forward spreading the sewage as they go, or fixed pressure nozzles which spray the sewage, distributing it in a manner similar to that of the ordinary lawn fountain. Where the fixed pressure nozzle is used it is generally operated under a head diminishing throughout the discharge period from a maximum of about 7 feet to the minimum, which varies from 1 to 2 feet. The dosing cycle may consist of a five minutes' dosing period and a ten minutes' rest period.

This fluctuation in head may be obtained by a butterfly or undulating valve, rotated in the supply main,

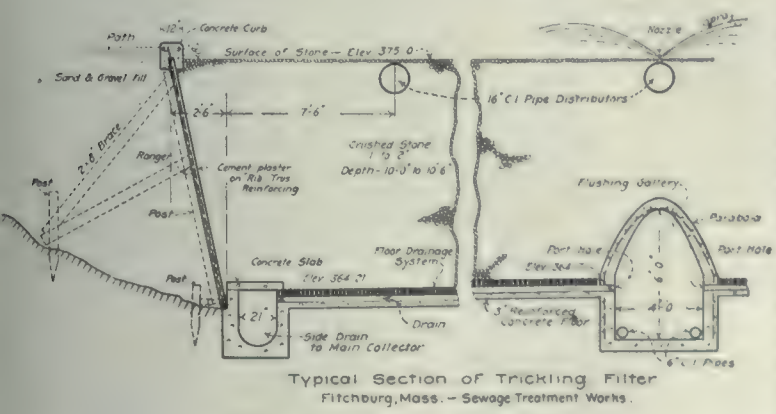


Fig. 3.—Typical section of trickling filter.

or by dosing tanks so designed as to provide the proper quantity of sewage at each head.

When sewage is first applied to a new trickling filter the suspended matter clings to the surface of the stones where it is temporarily retained, forming a suitable habitat for the bacteria present in the sewage. Thus a bacterial film, sometimes called bacterial jelly, is gradually built up, covering the surface of the stone of the entire bed. As the sewage trickles over this jelly-like substance, the finely-divided colloidal and some of the dissolved matter is retained upon and in it and apparently furnishes the food supply for the myriads of micro-organisms present. In this manner the sewage is deprived of its putrescible organic matter, which is gradually worked over by the organisms and ultimately given off to the passing sewage and carried away in the form of mineral or stable organic substances. It is of vital importance to provide the proper quantity of food supply and an ample opportunity for the absorption of atmospheric oxygen. The operation of the filter is approximately continuous, and thus has a distinct advantage over the contact bed, which of necessity is both dosed and aerated periodically. A typical section of a trickling filter is shown in Fig. 3.

A very highly efficient trickling filter will carry the process of oxidation so far that the effluent will keep indefinitely, and if the contact material is relatively fine, the suspended matter of the sewage and the colloidal matters withdrawn therefrom will be retained and a practically clear and sparkling effluent will be produced. Such a filter will cause a large reduction in the number of bacteria present in the original sewage. Trickling filters are ordinarily built of coarse stone, however, and contain interstices so large that the suspended matter which accumulates temporarily passes away after having been more or less completely worked over by the organisms. Such effluents are turbid and contain settling solids which are commonly removed in secondary sedimentation tanks. In fact, one of the primary objects in the design of trickling filters is to so construct them that the solids shall not accumulate indefintely in the stone, but may wash out from time to time and thus avoid the necessity of taking out the stone to free it from the accumulation of such substances which otherwise might ultimately clog the filter. It is necessary, therefore, under ordinary conditions, to accept turbidity and much suspended matter, as characteristics of the effluent from this type of filter, and to provide for the removal of the settling solids before its discharge into the diluting waters.

The underdrainage system of the trickling filter is of great importance, since it is necessary to convey the effluent away freely, and also to provide ample means for washing out humus when the bed discharges its accumulation. Many types of filter floor have been used for this purpose. The one used at Fitchburg, Mass., consists of a series of channels cast in the concrete floor, spanned with concrete beams or "bricks," the whole being covered with cobble stones before the filtering material was placed.

The walls of such a filter, if below the ground level, need be hardly more than diaphragms to prevent the material of the filters from mingling with

the adjoining earth, and to keep the sewage or effluent from escaping into the soil. Such a diaphragm wall, built by plastering reinforcing steel with mortar by means of the cement gun, was employed at Fitchburg, and is shown in Fig. 4.

Sand Filters

The intermittent sand filter is one of the oldest devices for the artificial treatment of sewage. It consists of a bed of sand from 3 to 5 feet in depth, enclosed within embankments and usually provided with underdrains. It is necessary to use a free draining sand, if filters are to be capable of handling a reasonable quantity of sewage.

As the name implies, these beds are operated intermittently. They are dosed by completely flooding the surface as quickly as possible, preventing excessive

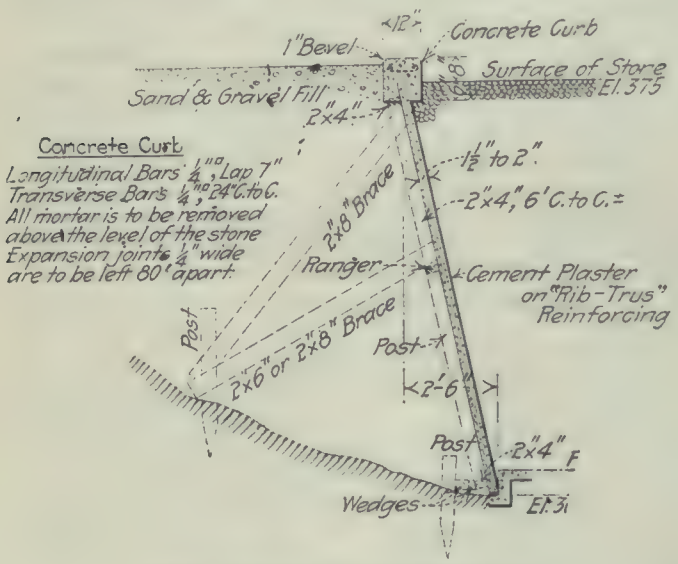


Fig. 4.—Details of wall for trickling system.

quantities of sewage from penetrating portions of the bed near the distributors, and thus aiding in uniform distribution. Dosing is best accomplished in the smaller plants by storing the sewage until the desired quantity has accumulated, when the dose is suddenly and quickly released by automatic apparatus.

The sewage percolates through the sand, where it comes in intimate contact with living organisms, as in the contact and trickling filters. In fact, the biological processes appear to be practically identical in these types of filters, although the oxidation is usually carried somewhat further in the sand beds. There is, however, one distinct difference between the sand filter and the trickling filter as ordinarily constructed and operated. The former, due to its fine particles and small interstices, retains the suspended solids mechanically, and is thus enabled to produce an effluent which is clear, sparkling and colorless. The trickling filter, as already explained, because of its large interstices, allows the suspended matter ultimately to pass through it, giving to the effluent a decidedly turbid appearance. A well-operated sand filter will carry the oxidation of the organic matter nearly to completion, converting it very largely into mineral substances. The bacterial reduction may also be far superior to that obtained by ordinary types of contact and trickling beds. Effluents in fact are obtained in which the bacteria are less than one per cent. of the number present in the original sewage, a result fully equal to that obtained by ordinary disinfection.

Obviously the retention of the suspended matter upon and in the sand causes a reduction in its capacity, and if this accumulation is permitted to increase indefinitely, the filter will become practically impervious to water. It is necessary, therefore, to provide for the periodic cleaning of the filters, which is accomplished by raking and scraping off the mat remaining upon the surface of the sand after the filter has become dry. Heavy mats necessitate frequent and expensive cleaning, which may be reduced, to some extent, by passing the sewage through sedimentation tanks before it is applied to the filters. It is usual, therefore, in such installations to combine with the sand filter, suitable sedimentation tanks for the removal of the coarser suspended matter.

The efficiency of sand filters, as well as of contact beds and trickling filters, is much lower during cold weather than in the summer. It is necessary to make ample provision for winter conditions, to avoid the freezing of the applied sewage in a solid layer adhering to the surface of the beds. This is accomplished by furrowing or by raking the surface material into piles, so that the ice sheet may be held up above the normal surface, thus providing a natural roof or cover, below which the sewage flows to the various parts of the bed, and, which protects the sand from extreme cold and snow.

BROAD IRRIGATION

It is hardly necessary to discuss here the merits and demerits of broad irrigation, the oldest method of artificial oxidation of sewage upon land. This method has found little favor in this country.

It is capable, under favorable conditions, of producing a very highly purified effluent—fully equal to that of the sand filter.

DISINFECTION

The methods of sewage treatment thus far described, deal primarily with the prevention of objectionable deposits and offensive conditions. Disinfection deals with the destruction of organisms. Normal municipal sewage may be said to contain about one million bacteria per cubic centimeter, while they frequently run as high as 10 or 20 million per c.c. in old and strong sewages. Of these the great majority are probably harmless. Pathogenic organisms, however, may be present in sewage and the object of disinfection is to kill such organisms, or to so reduce their numbers that they may not be a menace to health.

For this purpose calcium hypochlorite, or bleaching powder, and liquid chlorine, have been used. The quantity required varies according to the quality of the sewage or effluent to be disinfected and the extent to which it is desired to reduce the number of bacteria. The quantity of available chlorine used, varies from 3 to 6 parts per million, which is equivalent to 25 to 50 lbs. per million gallons of sewage. These quantities of chlorine are equivalent roughly to 75 to 150 lbs. of bleaching powder per million gallons of sewage.

This treatment is not likely to produce a sterile effluent, but will reduce the number of bacteria growing at body temperature,—37 degs. Cent.—from 75 to 90 per cent. and the coli from 90 to 95 per cent. Such disinfection has been assumed to be sufficient when the effluent was discharged into tide water above oyster beds and an adequate protection of the public where the discharge was into large streams or bodies of water from which water supplies were taken, provided they were efficiently filtered and disinfected before use.

The Activated Sludge Process

During the past two years the attention of sanitary engineers has been focussed upon a new method of sewage treatment known as the activated sludge process. This process appears to have been discovered accidently by Messrs. Ardern and Lockett, who presented the results of their original experiments at Manchester, England, in the "Journal of the Society of Chemical Industry," May 30, 1914. They found that when sewage was kept for several hours in intimate contact with sewage sludge, by agitation with a current of air, the sludge assumed the form of a light flocculent precipitate, the suspended and colloidal substances were attracted to and absorbed by these flocculi and the dissolved matters were oxidized, the free ammonia being transformed into nitrates.

Milwaukee Experiments

Many experiments with this method of treatment have been made, the most notable perhaps being those of the Milwaukee Sewerage Commission, of which Mr. T. Chalkley Harton is Chief Engineer, and Mr. William R. Copeland is Chief Chemist.

This process is still in an experimental stage, although at Milwaukee it was thought that sufficient progress had been made to warrant the construction of a two-million gallon plant, which was completed in December and has been in operation two months. The plant consists of eight round aerating tanks 30 feet in diameter and of sufficient depth to accommodate about 10 feet of sewage, including 20 per cent. of sludge. Partitions are so arranged as to confine the sewage to channels 6 feet wide, through which it flows continuously, passing from tank to tank. From the aeration tanks it flows to a sedimentation tank, being admitted at a considerable depth below the surface, and flowing upward to skimming troughs into which it flows in a thin film at the surface of the tank. Two tanks of similar size are provided for the storage and re-aeration of the sludge collected in the sedimentation tank. The plant is also provided with the necessary air blowers and measuring devices. The equipment for handling, dewatering and drying the sludge, has not yet been fully determined upon.

Method of Operation

While the methods of treatment in different places vary considerably, the concensus of opinion at the present time (1916) appears to be that operation by continuous flow through the aeration and sedimentation tanks is preferable to the fill and draw method which has been used in some of the smaller experiments. The process can be explained conveniently by describing the method of operation of the new Milwaukee plant as it is intended to be used when certain modifications have been made.

Sewage Aeration

Sewage flows continuously through the aerating tanks which are provided at the bottom with an air distribution system consisting of ducts above which are placed thin porous plates. These "filtros" plates are confined to a single row extending along the middle of the sewage channel. The air is admitted to the porous plates under a pressure slightly greater than that exerted by the overlying column of sewage. In this manner the sewage is constantly mixed with the sludge by the rising air, and at the same time the sludge and the liquid are afforded an opportunity to absorb oxygen from the air. Just before the sewage is admitted to the first aeration tank, it receives a dose of activated sludge, equivalent to 20 per cent. of its volume. The method of preparing this sludge will be described later.

The period of aeration is intended to be about four hours, which obviously corresponds to the length of time required for the sewage to flow through the eight aeration tanks. The quantity of air required for aeration of the sewage appears to be about 1.75 cu. ft. of free air per gallon of sewage treated.

Sedimentation

As it is important to maintain the sludge in intimate contact with all portions of the sewage in the aerating tanks, it is necessary to provide for sedimentation, immediately after the sewage leaves them. The flocculent precipitate, however, settles quickly and a clear effluent can be obtained from suitable sedimentation tanks. It is expected at Milwaukee to reduce the quantity of suspended matter in the sewage to less than 20 parts per million, as the effluent leaves the sedimentation tank. The suspended matter gradually falls to the bottom where it accumulates as a thin sludge.

Sludge Handling

From the sedimentation tank in which the sludge naturally contains 98 or 99 per cent. water, the sludge flows to a deep concentration well where it is hoped to reduce the water content to 96 per cent. or less. From this well the sludge may be pumped into the incoming sewage or, when necessary, to the sludge reservoirs where it is continuously aerated to reactivate it before pumping it to the raw sewage.

There are as yet very few data to indicate the quantity of sludge likely to be produced by the activated sludge treatment of sewages in general. The Milwaukee experiments indicate that the quantity will range from 3,000 to 6,000 gals. per million gallons of sewage treated. This sewage is relatively strong, its volume being equivalent recently to about 80 gallons per capita per day. It contains considerable industrial wastes and may produce an abnormal quantity of sludge.

Analyses of this sludge indicate that when dry it contains sufficient fertilizing ingredients to make its utilization commercially attractive. There are, however, serious difficulties to be overcome in dewatering and drying the sludge. Very little progress has been made upon this phase of the problem.

Theory of Action

The most noticeable effect of this treatment upon the sewage, is the formation of the precipitate called "activated sludge." It is light brown in color, apparently very light in weight, and readily forms loose aggregations called "flocculi," resembling precipitated hydrate of iron. These flocculi are found to contain vast numbers of bacteria, which appear to be absolutely essential to the success of the process. It is conceivable that they exude certain substances which give to these flocculi their peculiar absorptive and attractive functions, and which enable them, while passing through the sewage, to gather to themselves the

colloidal matter and bacteria, and to absorb certain of the dissolved substances.

The action of this sludge appears to be very similar to that of the bacterial jelly surrounding the stones of the trickling filter. The chemical changes which go on in the sewage, in both processes, appear to be practically identical. The efficiency, however, of the activated sludge flocculi, in holding the colloidal matter, appears to be greater than that of the bacterial jelly of the trickling filter, for the effluent from the aeration tanks, after proper sedimentation, is very clear and sparkling, while the effluent from ordinary trickling filters, even when in relatively good condition, is almost always turbid, even after the settling solids have been removed from it by sedimentation. The two processes although very similar in theory of action, are carried on under different physical conditions. In the case of the trickling filter, the sewage is the moving medium, passing slowly over the absorbing jelly, by which its finely divided particles and some of the dissolved matter are absorbed, and subjected to bacterial decomposition and oxidation. In the aerating tanks, on the other hand, the bacterial jelly is the moving medium, which, in contact with the sewage, attracts and absorbs the finely divided and some of the dissolved substances, and within its confines subjects them to bacterial decomposition and oxidation.

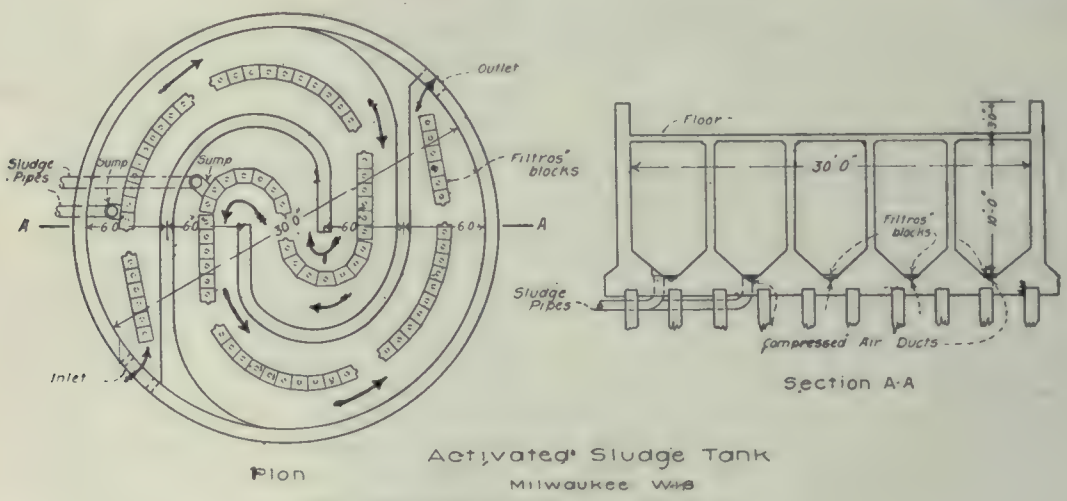


Fig. 5—Plan and section of activated sludge tank.

Character of Resulting Effluent

The well settled effluent from the aerating tanks as observed by the writer at Milwaukee is clear, sparkling and colorless. It contains ordinarily less than ten per cent. as many bacteria as were present in the original sewage; it is relatively stable, keeping under exacting laboratory conditions for from three to five days, even in the winter when there is practically no nitrification, due apparently to low temperature of the sewage. In warmer weather there should be no difficulty in producing a stable effluent and even a highly nitrified effluent.

Application to Trade Wastes

This method appears to be adapted to the treatment of certain trade wastes. Experiments being made by the writer upon tannery wastes, give promising results, while those upon paper mill wastes are not encouraging, probably because these wastes are not as susceptible to vigorous bacterial action.

It is too early to base estimate of cost of this process upon actual operating data. The expense will apparently be divided into two parts, that of the purification process and that of sludge disposal. Air alone, at the rate of 1¾ cu. ft. of free air per gallon of sewage treated, will cost about $14 per million gallons of sewage, if power costs 2c per kw.h. Few small cities can hope to purchase power at a much lower cost, and other methods of treatment are likely to prove more economical unless a profit can be realized from the sludge.

Analyses of activated sludge from different experimental plants vary widely. Some indicate the possibility of a return from sale of commercially dry sludge, sufficient to warrant the payment of a substantial sum for dewatering and drying, but what these processes will cost is now problematical.

Comparison of Results of Methods of Sewage Treatment

Sedimentation with or without screening, is capable of removing much of the suspended matter capable of settling in a short time. Referring again to the hypothetical sewage, by way of illustration, it may be assumed that this process will effect a removal of about 130 p.p.m. of suspended solids. This leaves 170 parts of suspended solids and 500 parts of dissolved solids —an highly putrescible effluent which is decidedly dirty in appearance. Such an effluent, however, may be turned into some streams and bodies of water without fear of causing serious deposits, and the quantities of diluting water may be such as to fully warrant such a course.

If, however, a better effluent be required, resort may be had to chemical precipitation, by which it is possible to remove colloidal and suspended matters more completely than by sedimentation, and to the extent of perhaps 290 parts per million, leaving 510 parts of suspended colloidal and crystalloidal matter in the effluent of the hypothetical sewage. A large part of this consists of soluble matter. Even this reduction is not sufficient to render the effluent non-putrescible, and it might be added that in most cases where this method has been employed the operating costs have been so curtailed that the results obtained have hardly been comparable with those of which the process is capable.

The quantity of suspended and colloidal substances removed by screens, grit chambers, sedimentation and chemical precipitation may be tabulated as follows.

Coarse Screens	5 to 10 parts per million
Fine Screens	20 to 70 parts per million
Grit Chambers	10 to 40 parts per million
Plain Sedimentation	130 parts per million
Chemical Precipitation	290 parts per million
Activated Sludge, more than ...	290 parts per million

All of these methods, therefore, leave in the sewage some suspended and colloidal matter and practically all of the crystalloidal substances. Where further purification is required, methods of oxidation are employed.

The results obtained by bacterial oxidation in sand or stone beds, have varied greatly. The best results can be obtained undoubtedly by the use of sand filters, with which a clear, sparkling non-putrescible effluent can be produced without difficulty. Such an effluent is as good as can be obtained by any of the available processes and may contain no more bacteria than a well disinfected settled sewage.

The activated sludge method produces a clear, sparkling, well-oxidized effluent. Its bacterial efficiency apparently approaches that of the sand filter, as does its power of oxidation and removal of organic matter.

To any one of these methods it is practicable to add disinfection with chlorine, which will reduce the number of organisms to such an extent that the discharge of the effluent into tidal waters or into large bodies of water from which water supplies are taken and properly filtered and disinfected, should not endanger health.

By available methods it is practicable to produce an effluent of almost any required degree of purification. Local conditions in one place may favor the adoption of one method, while those of some other city may warrant an entirely different process. In general, where large bodies of water are available for dilution it is unnecessary to adopt artificial means of oxidizing the organic matter. While natural resources for the oxidation of sewage should be utilized as fully as is compatible with the general welfare, they should not be abused by the discharge of overtaxing loads of organic matter into streams and waters, by which their value of natural resources is destroyed wholly or in part.

The problem before the engineer today is not so much how it is possible to purify sewage as it is to determine to what extent the sewage should be purified to meet the existing conditions and by what process can this be most economically accomplished.

Waterworks and Sewerage Operations in the Town of Simcoe

By W. C. McCall

THIS was established in 1907, at a cost of $76,000. Extensions since that date, $20,000; total cost $96,000. We adopted the meter system at once, and have in use nearly 700, although we have a flat rate for single taps of something over 200.

Our total mains and extensions amount to over twelve miles, so that nearly every taxpayer is accommodated. With 74 hydrants, our fire system is all that could be desired, having a standpipe pressure of 60 pounds and a fire pressure of 125. We have a simple and unique way of closing off the standpipe during a fire that would have to be seen to be appreciated, handled by the engineer at the pumping station, 2,000 feet away—a simple matter of hydraulics and the only one used in Canada. Average daily pumping, about 160,000 gallons, showing the benefit of the meter system.

Water comes from a number of springs, and runs through galleries to the station. The springs and galleries are 12 feet under ground, so that the water is cool and pure, having no contamination from any source.

Meter rates are reasonable for a small town—from $4.00 up, according to size. Water rates are 15 cents per 100 cubic feet maximum; 4½ cents minimum, according to amount used. A minimum charge of $6.00 is made on every service per year. Ten per cent. discount is made on all accounts paid before tenth of the month, rates collected quarterly.

Sewerage Department.

This was installed in 1914, at a cost of $130,000. We use one pumping unit of 25 h.p., electrically driven, and an auxiliary of a 25 h.p. natural gas engine, working separately.

Our septic tanks are not strictly Imhoff, being designed by Willis Chipman C.E., of Toronto, and do their work well. We have four settling basins or beds, where the fluid filters after leaving the septic tanks. The whole system is working well, and is a credit to a town of our size. It is an expensive necessity, but is worth it.

More Underground in Montreal

The City of Montreal having decided that the high-tension conduits should be owned, operated, and controlled by the power companies, the Montreal Tramways Company have just placed contracts for the construction of a high tension 13,200-volt conduit system to inter-connect their several power houses and substations on the Island of Montreal. The tenders have been let to G. M. Gest, Limited, Montreal, and Quinlan & Robertson, Limited, Montreal, each contracting firm building approximately half of the total system, which it is expected will be completed this year. Specifications and tender forms have been issued for the necessary cables. The conduits will be of vitrified clay "Camp" duct, 4¼ in. round bore. The manholes will be of brick construction.

Royal Architectural Institute Assembly

The general annual assembly of the Royal Architectural Institute of Canada will be held at Quebec on September 8-9, 1916. A very interesting programme is being prepared, which will include matters of interest to every architect in the Dominion. Every Canadian architect is cordially invited, and is welcome at all sessions, whether a member of the Royal Institute or not. The programme will be sent at an early date to every member of the Institute, and will contain all particulars concerning the assembly. Alcide Chausse, 5 Beaver Hall Square, Montreal, is honorary secretary of the Institute.

Intercepting Sewer, St. Lambert

Representatives of St. Lambert, Longueuil, Montreal South, and Greenfield Park, on the south shore of the St. Lawrence, have agreed to take steps for the construction of an intercepting sewer which will receive the sewage from all four municipalities and discharge it at a point below Longueuil. Two municipalities will choose an engineer, the other two another engineer, and these will appoint a third to investigate the question of cost and its apportionment among the municipalities. It is also proposed to form a standing committee of the municipalities to look after the water, and drainage of the districts.

Electrics Used in Refuse Collection

Experiences of an English Superintendent Favorable—Opinion Upheld by a Number of Municipal Officers

By J. Terry*

Having given much thought and consideration to the various papers relating to motor traction given at our conferences during recent years, I had decided that motor vehicles were not suitable to the peculiar conditions which prevailed in Nottingham.

Many of you will no doubt remember that our conference last year synchronized with an exhibition organized by the Road Board at the Horticultural Hall, where vehicles of various descriptions were displayed, and it was there I saw the first electric vehicle, with which I was very much impressed. From the information then received, and from my previous knowledge, I summed up the advantages and disadvantages of the various vehicles as follows:—

Petrol-Driven Vehicles

Advantages:
- Moderate capital cost.
- High speed.

Disadvantages:
- High running costs.
- Proved inability to withstand constant starting and stopping.
- High maintenance costs.
- Heavy tire expenditure.
- Dear fuel. Fluctuating price of same.
- Many working parts.
- Motor running while vehicle stands.
- Noisy on low speeds.
- Skilled drivers needed, and special maintenance staff.

Steam-Driven Vehicles

Advantages:
- Moderate capital cost.
- Satisfactory speed.
- Cheaper fuel.
- Satisfactory starting and stopping.

Disadvantages:
- Constant wastage of power when standing.
- Skilled labor to manage, and then two men required.
- Costly maintenance.
- Heavy tire expenditure.
- Frequent loss of earning power during overhaul.
- Fear of boiler troubles.
- Noise—steam exhaust offensive.

Electric

Advantages:
- Ample speed.
- Ability to withstand starts and stops.
- Very rapid acceleration.
- Few moving parts, therefore low maintenance.
- Cheaper tires (initial cost).
- Less wear on tires owing to easy turning movement.
- Cheap fuel at fixed prices.
- Ease of control, therefore horse-men prove successful drivers.

By employing the electric there would be no noise, odor, smoke, gears to change, no clutch, no carburettor to adjust, no ignition troubles, or no boilers to overheat; therefore I could not fail to lean towards this vehicle, which had to be used on the heaviest possible work, with a staff whose engineering experience was, to say the least, modest.

Heavy Initial Cost

While I favored the electric vehicle, I did not approve its high cost, and did my utmost to obtain a reduction. I found that the manufacturers, although keenly competitive, were unable to reduce their charges, the reason for this being that the output of electric vehicles is very small compared with other types of vehicles. The works costs must therefore remain high until the demand grows. Added to this, the high cost of freight and insurance brings about a total which appears very heavy compared with the purchase price of petrol and steam vehicles available on their merit at their present prices. I found that users had experienced little or no maintenance, and that the claim that an "electric" was good for a life of even so much as fifteen years, without undue maintenance, was likely to prove true. This materially simplified the proposed initiation, with the result that I advised my committee to make an immediate experiment, which suggestion was promptly acted upon.

I then decided that I needed vehicles of 3-ton capacity, but I have since seen that a mixed fleet of 2 and 3 tonners working in pairs of equal capacity will be ideal for the convenience of our town. The body must be of sufficient capacity to carry the load under average conditions, but no concern need be felt when the weight per cubic yard exceeds normal, as no vehicle of good design should be strained under the occasional maximum conditions.

High speed would be no advantage, for when working in pairs the maximum speed required is governed by the speed of filling. It would obviously be a fallacy to accelerate speed if the empty vehicle has to wait while the second vehicle is nearing the completion of loading, and alternatively the capacity of body is governed by the distance the loads have to be taken. A speed of from 9 to 12 miles per hour is ample.

It was essential that, whichever power was selected, the vehicle must be capable of starting and stopping upon all levels and conditions of road without causing undue maintenance. The simplicity of the mechanism convinced me that the "electric" would excel in this respect.

Batteries

The next and more difficult point to decide was the selection of battery. When I first mentioned electrics to my chairman he opposed the idea, on the ground that his experience of them was not satisfactory. I replied that I was not surprised, as undoubtedly he had been using lead batteries, and as this may have been the experience of others I trust you will excuse me if I appear to dwell somewhat on this point.

I do not pretend to be an electrical engineer, but I have friends whose advice is worth seeking. Upon hearing my requirements they sagely shook their heads and gave ma many hints on the upkeep of lead batteries, which were of a more or less bewildering nature. I then chanced to meet with a pamphlet describing the upkeep of a traction lead battery. The following is a part of the article in brief outline: "All positive plates slowly disintegrate during their working life, though, as will be shown later, the rate of disintegration is largely controllable by the user, depending upon the care exercised in avoiding free and violent gassing in the course of charging the battery. But, slowly or quickly, the process of shedding the active material goes on, and unless

* Cleansing Superintendent, Nottingham, at Annual Conference of the Institute of Cleansing Superintendents, held at Cardiff, England.

ample space is provided for the reception of material so thrown down, it will soon accumulate to a level where it touches the plate, when it 'short circuits,' or, in other words, makes a circuit inside the cell. Unless the cells be immediately cleaned out—and this involves time as well as a certain amount of skill and expense—the plates will soon be ruined."

I need hardly state that such precaution seemed difficult when the nature of our work was considered, and it was a considerable relief to find upon examination that the "Nickel Iron Accumulator" battery was free of weaknesses such as have been described. I agree that the imperfections of the lead battery may be more aggressive when explained in cold print than when handled by skilled electricians. I had to remember that skill in handling does not end the care necessary for successful maintenance. Much harm can be done to the battery by careless discharge, and temporary short circuit, if not absolutely disastrous with some types of lead battery, at least causes inconvenience, and may entail its removal from service. This would necessitate spare sets and special appliances for the easy removal of approximately three-quarters of a ton of cells by the means of lifts, jacks, trucks and similar contrivances.

Obviously in this class of service it is essential to have the battery dust-proof and mechanically strong. This you will agree is even more necessary than very high efficiency, for current is cheap, whereas battery maintenance is expensive. In the nickel iron battery I believe we have a battery which is almost indestructible within a reasonable service. Certainly the manufacturers believe in its longevity, for they have formulated a special guarantee which states that on the completion of 60,000 miles service the battery will still show its original rated capacity, failing which, they will at their discretion bring the cells within the specification, or replace same free of charge. This guarantee is subject to certain conditions as to maintenance, which are simple to follow and offer no loophole whereby the terms of the guarantee can be avoided.

As the mileage per day on refuse collection is from 15 to 22 miles, the average can be taken at 20 miles per day, which represents at 300 days per annum a ten years' guarantee. The manufacturers stipulate that the maximum period of the duration of the guarantee is eight years. It is comforting to know that, notwithstanding this shortening of the actual period of guarantee, "service" is the destroying factor — not "idleness." Since there are many instances where Edison batteries have much exceeded 100,000 miles service in heavy-draught vehicles, it seems probable that the capital write-off at 10 per cent. per annum is much too conservative. At this rate of reduction of value the vehicles successfully carry out the work at a price hitherto unheard of with horse traction; therefore it is wise to retain the figures and benefit at a later date should my calculations prove too pessimistic.

The cost of the best type of lead battery is about half that of the nickel iron. Certain makes carry no guarantee whatever, but for a fixed sum per mile a battery maintenance can be arranged. Other makes are guaranteed for a minimum of 20,000 miles. In the event of this mileage not being completed, then a new battery is equipped at a reduced cost proportionate to the lost mileage. That is to say, if 15,000 miles only is completed, then the replacement will cost 75 per cent. of a new one, subject to the fluctuations of the metal market.

Cost of Current

The guarantee of the iron battery has been already stated, and from a business point of view I can, without any highly technical knowledge of electricity, appreciate the fact that on guarantees the nickel iron battery is undoubtedly much superior and more conclusive. Then comes the question of efficiency. The cost of current at 1d per unit (which is the almost universal charge for traction current, but, unfortunately, not so in Nottingham) will average approximately 2s. per day. What is the difference of 10 per cent. in efficiency? This is the admitted advantage of the more efficient lead cell. I repeat, what is this small charge compared with the much higher maintenance costs? I doubt if the difference will cover the loss and inconvenience occasioned by the vehicle being out of commission while the lead batteries are being periodically overhauled and defective plates being replaced.

While on the point of cost of current it is well to remember that where destructors are available so can electricity usually be found, or the necessary plant be installed at a cost not affecting the proposition whatsoever.

The makers of the Edison battery give me the following description of the construction of the nickel iron battery: The Edison battery is composed of a number of steel plates contained in corrugated nickel steel containers. The positive plate contains alternate layers of nickel hydroxide and pure flake nickel, this material being supported in spirally made steel sheaths, the edges of which are overlapped, the whole being submitted to a very high pressure during filling, rendering the contents to a rock-like nature. These are further encased with a number of small steel rings. These pencils are supported in frames made of the same material. The negative plate consists of a number of perforated steel pockets containing iron oxide, similarly supported. The opposite poles are supported by pure rubber strip sheets and frames in a concentrated form, the heavy cost of which, I understand, is largely responsible for the high cost of the cells.

The electrolyte is non-acid, and is composed of a solution of lithia and potash. These ingredients are interesting, inasmuch as it is known that potash is a preservative to steel; all the metal parts being of steel, it is probably due to this fact that the long life of the plates may be confidently anticipated.

With regard to maintenance, so far no cost has been involved, but a small sum of money has been set aside to ward against possible expense at a later date. It is usual to add distilled water to each cell by means of an automatic device two or three times per week, depending upon the climatic conditions. The frequency of these operations is regulated by the amount of evaporation. The filling device indicates whether the cell requires more water, by means of a bell or buzzer, which is vibrated when filling is normal. This process occupies from six to ten minutes, and is carried out by unskilled labor. The exterior of the containers is submitted to a bath of nickel, and afterwards painted with an insulating paint known as Esbalite. It is important that cleanliness be observed, and that the cells be regularly repainted should the original coating of Esbalite have flaked off, which is sometimes observed. These precautions are taken with a view to preventing rust, and negligence in this direction may cause leakage to the containers which cannot be repaired, but must be replaced. The replacements of the cans will not destroy the value of the plates, and while the expense is little, such a debit need not be incurred provided ordinary precaution is taken. The Edison battery is totally enclosed, the filling aperture being provided with an ample cap in which is contained a ball valve which prevents foreign matter from encroaching. At the same time it breaks the globules of electrolyte. These are thrown up in an effervescent form during high rates of charge and discharge, and are thus returned to normal useful condition.

Working Costs

In the report presented to my committee in September last I submitted estimates from the makers of various vehicles and the results of special tests made at Barnes,

Heston, and Isleworth, Dover and Sheffield, which figures I can supply if desired; but as we now possess figures covering fairly long periods under normal working conditions I think these are preferable.

During six months ending July 1, 1915, the cost of emptying dry ashbins by horse vehicle in Nottingham averaged 4s. 4d. per ton, but owing to the increased charges for horse-keep, wages, etc., the cost is now 5s.

Our No. 1 motor was delivered on October 15, 1915, commenced work on the 18th, and has been in use daily ever since. During the six months ending April 15th it carried 422 loads, weighing 1,288 tons, at a cost of £241 13s. 10d., which is equal to 3s. 9d. per ton, the average weight per load being 3.05 tons.

The costs are made up as follows:—

	£	s.	d.
Depreciation at 10 per cent.	52	13	0
Insurance	4	5	0
Oil, water, repairs, etc. (allowed)	11	9	8
Tires—1,819 miles at 1.1d.	8	6	9
Current—2,541 miles at 1¼d.	13	4	8
Wages	151	14	9
	£241	13	10

If we take the six months ending July, 1916, we get a period corresponding to the period covered by the figures given in my original report, and this is a more fair comparison than taking the first six months' work, which are all winter months. We find that during this time we removed 1,167 tons of refuse, at a cost of £253, or 4s 4d per ton, which is exactly the same as the cost by horses, as mentioned in my original report; but it must be remembered that the conditions then were the same as before the war. Under existing conditions, as I have already stated, the cost is 5s, thus showing 8d per ton in favor of the motor, which means that if all our dry-ash refuse were removed by motors a saving of over £1,000 per annum would be effected, and this in a town which I consider not best adapted to motor traction for this class of work. I have dealt only with the results obtained by our No. 1 motor, but the figures for the No. 2, which has been at work daily since March 13th, are identical.

Mr. Priestley, cleansing superintendent, Sheffield, whose experience of electric motors in the collection of house refuse is greater than that of any other superintendent, recently presented a report to his committee, from which I have pleasure in submitting the following figures:—

No. 1 Vehicle.—Day Work Costs for twenty-two weeks.
Refuse collected, 858 tons, 6 cwt. 1 qr.

	£	s.	d.
Wages	154	15	8
Vehicle costs	40	7	1
Electricity, 3,269 units	13	12	5
Tires, 2,168 miles	9	0	8
	£217	15	10

Cost per ton, 5s. 0.8d.

Cost of one month's work on same districts with horse labor:—

Refuse collected, 167 tons, 19 cwt., 2 qrs.

	£	s.	d.
Cost	59	1	9

Cost per ton, 7s. 0.4d.

No. 1 Vehicle.—Night Work Costs for twenty-one weeks.
Refuse removed, 1,142 tons, 19 cwt., 1 qr.

	£	s.	d.
Wages	72	3	8
Vehicle costs	38	10	5
Electricity, 2,927 units	12	3	11
Tires, 1,880 miles	7	16	8
	£130	14	8

Cost per ton, 2s. 3.4d.

Cost of three months' work on same districts with horse labor:—

Refuse removed, 473 tons, 11 cwt., 2 qrs.

	£	s.	d.
Cost	77	10	3

Cost per ton, 3s. 3.2d.

No. 2 Vehicle.—Day Work Costs for six weeks.
Refuse collected, 314 tons, 4 cwt., 3 qrs.

	£	s.	d.
Wages	47	10	5
Vehicle costs	10	19	3
Electricity—670 units	2	15	10
Tires—417 miles	1	14	9
	£63	0	3

Cost per ton, 4s. 0.1d.

Cost of one month's work on same district with horse labor:—

Refuse collected, 204 tons.

	£	s.	d.
Cost	38	16	0

Cost per ton, 3s. 9.6d.

No. 2 Vehicle.—Night Work Costs for six weeks.
Refuse removed, 406 tons, 13 cwts., 2 qrs.

	£	s.	d.
Wages	21	18	0
Vehicle costs	10	19	3
Electricity—758 units	3	3	2
Tires—459 miles	1	18	3
	£37	18	8

Cost per ton, 1s. 10.3d.

Cost of one month's work on same district with horse labor:—

Refuse removed, 440 tons, 8 cwts.

	£	s.	d.
Cost	55	10	2

Cost per ton, 2s. 6.2d.

Mr. Jackson, cleansing superintendent, Birmingham, who has been working an "Orwell" dust van since May 29th, reports that it is equal to 2.5 horses.

Even if the running costs and standing charges of motor vehicles are only equivalent to the present cost of horse collection, I most strongly contend that from a sanitary point of view the change is to be recommended. I feel personally that too much emphasis cannot be brought to bear on what appears of national importance, for the following among many other reasons which no doubt will occur to you:

(1) Cleanliness of street.

(2) Labor provided for building chassis in this country.

(3) Reducing the demand for fodder and cereals for horses.

(4) Correspondingly increasing the supply available for feeding cattle.

From a hygienic standpoint the value of No. 1 alone compels us as cleansing superintendents to be in the front rank in adopting this improved form of traction.

In conclusion, it is worthy of mention that my faith in the success of electrics is upheld by many other municipal officials who with myself have franked their good opinion by placing orders and repeat orders as follows: Edison Battery Vehicles.—Sheffield, 5; Chester, 4; Dover, 6; Barnes, 4; Glasgow, 2; Pontypridd, 2; Newcastle, Heston and Isleworth, South Shields and Smethwick, 1 each. Lead Batteries.—Birmingham, 2; Wolverhampton, 1. In many cases reports have been made, in each of which substantial savings have been made.

New Books

Waterworks Handbook—by Messrs. Flinn, Weston and Bogert. McGraw-Hill Book Company, publishers; price $6. This is intended as a reference book in regard to all phases of waterworks engineering. It has been compiled by the authors from data collected during the course of their extensive consulting practices. The work is divided into five parts: Part 1, sources of water supply; part 2, collection of water; part 3, transportation and delivery of water; part 4, distribution of water; part 5, character and treatment of water. Each topic is divided on natural and obvious lines and its divisions arranged in natural sequence. Material not readily classified under the above topics has been assembled under the heading of "Miscellany." A noteworthy feature of the information contained in the book is that it has been based to a very extensive degree upon data collected from actual instances of waterworks installation. In this way it is eminently practical. Every known phase of this important branch of engineering is treated in a very comprehensive manner and arranged so as to be easily available for reference. The text is replete with numerous illustrations and tables. A feature worthy of note is the numerous comparative tabulated forms which allow comparisons between practices in various parts of the continent. The book contains 801 text pages, 311 numbered tables, and 411 numbered illustrations. Size about 6 x 9 inches; flexible cloth cover.

Annual Financial Review

Many a successful man in the building trades owes that success to his ability, at some critical time or other in his career, to furnish sufficient security in the form of good stocks or bonds to secure the co-operation of his banker. Within recent years indeed, this practice of business men of every kind putting a certain percentage each year into some liquid form of investment, in no way connected with their own line of business, has tended to stabilize trade in general and is now coming to be looked upon as one of the best forms of insurance against financial difficulties that so frequently follow the inevitable lean years. Strange as it may appear, however, these knights of industry, so prominent in their own field of manufacturing, contracting, or what-not, often know little of finance, and if they invest at all, must do so without first hand knowledge and on the advice of someone who may not be entirely disinterested or whose judgment may be at fault. To men in business life who wish to invest against a rainy day and who believe in knowing the history and past performances of any security before placing their money, we recommend a study of the "Annual Financial Review," compiled by Mr. W. R. Houston, of Houston's Standard Publications, 84 Bay Street, Toronto. The 1916 issue is just off the press. It is a carefully revised resume of facts regarding Canadian securities, than which there are no more promising to be found the world over. This book does not advise or predict. It is a bald statement of what Canadian stocks have done in the past—the best, and indeed the only, data on which estimates may be based of future performances. The price is $6.00 net. By the habitual investor it will be found to contain information of great value as a foundation on which to base his decisions. In the man who does not yet know the joy of receiving his first dividend cheque, it may perhaps be the means of arousing an interest in sound investments which will help him to spend his declining years in greater comfort and peace of mind.

During the month of July 20 building permits were issued in Vancouver, the aggregate value being $156,465, making the second largest total for the present year. In July of last year the permits were 33 in number, the value being $171,065.

Mainly Constructional

East and West—From Coast to Coast

The fire loss in the United States and Canada for the last ten years has averaged $230,000,000 a year.

Feldspar & Clay Products, Limited, have been incorporated with a capital of $1,500,000, head office Wiarton, Ont.

The Dominion Steel Products Company, Limited, has been incorporated with a capital stock of $500,000, head office Brantford, Ont.

The building permits issued at Trail, B.C., for the month of July have created a new record for that city. The permits numbered 26, at a value of $42,000.

The cornerstone of a school at Dominion City, Man., was laid recently. The new school will be a commodious six-roomed structure of brick construction.

Gray & Dunn, Montreal, have received a contract for an extension to the St. Jerome, P.Q., plant of the Canadian Consolidated Rubber Company, Limited, Montreal.

Letters patent of incorporation have been granted to the Confederation Sand & Gravel Company, Limited. John Soper, of the city of St. Catharines, Ont., is attorney for the company.

The Quebec Shipbuilding & Repair Company has been incorporated with a capital of $40,000, head office Montreal, Que. The firm will carry on the business of shipbuilders and shipwrights.

The Chicago Construction Company, Limited, has been incorporated, and will carry on the business of general contractors and engineers. The capital stock of the company is $40,000, head office Windsor, Ont.

Commissioner Macallum, of Ottawa, proposes to put the city's asphalt plant into shape so that the city may economically do paving with it and be in a position to bid against private contractors in connection with civic works.

The Dominion Steel Products Company propose to build a factory at Brantford, Ont., at a cost of $50,000, and to employ about four hundred hands. The city council have passed a by-law granting them a fixed assessment of $10,000.

The Ontario and Quebec Granite and Marble Platers' Association held their first joint convention in Montreal on August 7 and 8. This meeting is expected to be a forerunner of a national association embracing all the provinces of Canada.

A contract for the construction of a two-storey building 128 x 57 feet, for the Canada Paper Company, Windsor Mills, P.Q., has been awarded to A. F. Byers & Company, Limited, Montreal. The building will be of brick and reinforced concrete.

The Poole Construction Company, Regina, have secured the contract for a $25,000 addition to the office building for the Saskatchewan Co-operative Elevator Company, Limited, of that city, work to start at once. Construction will be reinforced concrete and brick.

The annual meeting of the Ontario Steel Products Company was recently held in the company's office, Gananoque, Ont. The financial statement, which has already been published, was highly satisfactory to the shareholders, despite war conditions.

A Presbyterian church is under construction at Bathurst, N. B. The building will be of brick, with granite trimmings. The contract for the brick work has been let to Mr. Robert Forrest, of Chatham, while Mr. Joseph Blanchard,

of Bathurst, is looking after the carpentry. The structure has been designed and planned by Messrs. Chappell & Hunter, architects, Charlottetown, P.E.I. The work of construction is now being carried on under their direction.

The United States Government will start work in the near future in opening the United States side of the St. Clair River in the vicinity of Sarnia. At the present time the Canadian side is used by all big boats. The new cut will have a depth of 21 feet, will be 450 feet in length, with a width of 400 feet.

A fine new building is under construction in Trenton, N.S., on Main Street. This structure, of which Mr. F. R. Clayden is the owner, is to be completed early in the fall, when it will afford accommodation for three large stores. It will be of solid concrete construction and will be built in the most modern and up-to-date style.

Coquitlam District Council has authorized the installation of a water system for Maillardville, the little hamlet adjoining Fraser Mills, where the huge plant of the Canadian Western Lumber Company is situated. Iron pipe will be laid by day labor under the superintendence of Fred L. Macpherson, municipal engineer of Burnaby.

Tenders have been received for the construction of a corrugated iron mill and power house at Delorimier Avenue, Montreal, for Thompson & Norris, of Grand Falls, Mass. The building will be on a site 100 x 190, and will be three storeys high, with provision for additional accommodation. It will be of reinforced concrete, slab construction.

At Eburne, Lulu Island, B.C., the Pacific Steel Products Company are installing a fine plant, including a steel rolling mill, which has just recently been got under way. The plant is still in course of construction, but already fifty men are employed. Electric power is used exclusively, being supplied by the B. C. E. R. Co. from their Steveston line.

On account of the lack of help a number of brickyards in the Mount Denis district, near Toronto, have been forced to close down. The wages of the brickmakers have jumped considerably, and according to a statement of W. Muchan, the manager of W. Pears' brick yard in that vicinity, the skilled men are making from $30 to $40 and more a week, while laborers average $25.

Victoria manufacturers, who have long been complaining of excessive water rates, are at last in line for relief. The present manufacturing rate varies from 17½ to 22 cents per 1,000 gallons, while the residential rate is 12½ cents per 1,000 cubic feet. Water Commissioner Rust has recommended that the manufacturers be supplied on the same basis, which will mean a considerable saving for over nine hundred consumers.

Track-laying has been resumed on the Pacific Great Eastern Railway line at Clinton, and rapid progress is expected from this time forward, the officials having overcome the labor shortage. Work on the big bridge in that district is well advanced, and the structure will be completed in the course of a few weeks. Already considerable freight is moving over the Coast section, and settlers are locating along the line in considerable numbers.

At the recent convention of the Dominion Association of Fire Chiefs a resolution was passed approving the suggestion of Mr. Wentworth, of Boston, Secretary of the National Fire Prevention Association, that October 9 be observed as an International Fire Prevention Day, and requesting that the proper authorities of each province obtain the consent of their respective governments to a full co-operation in an effort to make the day notably successful.

In connection with a new sub-station at Hochelaga for the Montreal Tramways Company, a contract for the construction of the superstructure of the reinforced concrete and brick boiler room has been let to the Raymond Construction Company, Montreal. The Tramways Company is also extending its St. Denis sub-station, and has accepted the tender of Laurin and Leitch, Montreal, for the work. The steel for the former building will be supplied by the Dominion Bridge Company, Lachine.

The city of Nanaimo has decided to begin the construction of modern roadways, the leading citizens being dissatisfied with the poor appearance and uneven surfaces of their leading thoroughfares. In order that the property-owners may be encouraged to face the heavier initial cost the city will pay for all preparatory work, such as grading, draining and engineering expenses, owners being assessed only for the actual cost of the pavement in front of their property, and this will be spread over a period of fifteen or more years. The city will pay for all paving at street intersections.

The terms of Mr. F. F. Fry, covering the construction of the pumping station in connection with the new sewerage system being constructed jointly by the municipalities of Mimico and New Toronto, have been accepted by the joint committees. R. B. Stewart, who previously tendered on the work, was unable to fill the contract, and Mr. Fry, who also tendered on the work last year, quoting $5,700 as his price then, stated that he would do the work this year for 20 per cent. above his original bid. It was therefore thought advisable to let the contract to Mr. Fry in order to prevent any further delay.

The government have decided not to proceed with the construction of the new Customs House and Examining Warehouse at Toronto, the estimated cost of which was $1,500,000. Several tenders for this work were received, and the contract provisionally awarded to the Geo. A. Fuller Company, Limited, Montreal. The cheque of that company has now been returned, it being understood that the government will not proceed with the work until a much later date. The government have also decided to postpone the construction of the Levis Station, bids for which were recently received.

Plans were recently placed by the Toronto-Hamilton Highway Commission, before the council of New Toronto, Ont., covering a material yard and a railway which the Commission wish to build in New Toronto for hauling supplies for construction of the highway from the Etobicoke River to the city of Toronto. The plans had already been approved by the property owners affected and the Grand Trunk had agreed to track connection, so the council consented to give their approval. The councils of New Toronto and Mimico are very anxious that this section should be built this year and a deputation is interviewing the Minister of Public Works in regard to the matter.

The Toronto Board of Control has had under consideration a plan for affording protection to the lake shore frontage between the east side of Woodbine Avenue and the east city limit, a distance of 6,694 feet. To do this in the cheapest form would cost approximately $41,000, according to the joint report of Parks Commissioner Chambers, Commissioner of Works R. C. Harris, and E. L. Cousins, manager and chief engineer to the Harbor Board. To accomplish more permanent and effective protection by the use of groynes, would cost about $70,000. The controllers decided that if any protection was to be afforded the residents would have to provide it at their own expense.

Machinery for the pumphouse of the Lemieux Island overland pipe water system has arrived in Ottawa. The foundations for the pumphouse building, which was to have been completed by October, are not yet erected, however, and the work will not be completed till several months after the time specified in the contract. The contractors, Messrs. Doran and Devlin, claim that they were held up

by the city through being ordered to stop blasting work owing to damage done to the hypochloride tanks. One of the two pumps ordered from the Escher-Wyss Company, of Switzerland, has been delivered. Valves and other equipment have also been delivered and stored.

A road improvement scheme to be undertaken at Port Perry, Ont., will comprise the construction of concrete roads as follows: From the railway crossing, west along Queen street to the creamery at Borelia; from Widden's corner to the northern limit of the Corporation at Bear's farm; from Bear Bros.' garage, south past the Catholic Church, then along the Avenue to the Corporation limit. The total cost of the work will be about $25,000, and it will probably be completed within four years or less. Forty per cent. of this amount is to be paid by the ratepayers whose property faces the improved roadway and the remainder, by the Corporation. The money is to be raised by issuing debentures to cover a period of twenty years.

The convention of the Dominion Association of Fire Chiefs, held at Walkerville, Ont., August 8 to 11 inclusive, proved very successful. There were about 200 persons present on the morning of the 8th when the convention was formally opened and the fire chiefs received addresses of welcome. The business sessions were rendered especially interesting by instructive addresses which were delivered by members of the association and others well fitted to discourse on subjects associated with the work of the fire departments. Amongst these were Mr. Franklin H. Wentworth, of Boston, Mass., the secretary of the National Fire Prevention Association, who spoke on the "Significance of Fire Waste." The business of the convention was intermingled with pleasure and there were enjoyable outings, parties, etc., in which both the fire chiefs and the ladies who accompanied them, joined.

The new C. P. R. station at Quebec was formally opened on the 10th inst., Mayor Lavigueur performing the ceremony. The building is located at the corner of St. Paul and Henderson streets, just north of the old station. The latter will be removed to make room for the plaza, 350 x 285 ft., which will form a foreground with a large grass plot planted with shrubs and having a sixty-foot roadway. The structure, which consists of a central block with two wings, is a modern adaptation of the old French Chateau style of architecture and harmonizes with the quaintness of the city. The exterior is faced with Argenteuil granite, Deschambault limestone and Citadel brick, all local products, with steep, sloping, copper covered roofs. The main facade, which faces the plaza, is dominated by a central motif containing the main entrance, which is flanked by two tourelles and protected by a glass and iron marquise the full width of the sidewalk. Over the main entrance is a large window, above which is an illuminated clock with a 72-inch dial, which forms one of the principal features of the facade.

Personals

Lieut.-Col. C. J. Burritt has been appointed assistant director of engineering services with headquarters in Ottawa. He is an architect and engineer by profession, formerly practising in Ottawa.

Chairman McIntyre and Engineer Middlemist, of the Ontario Railway Board, recently inspected the work on the Bloor Street Viaduct, Toronto. They have also made an inspection of the improvements ordered by the Board on the International Railway Company's line at St. Catharines.

Mr. Henry Ward Beecher, of Seattle, a member of a leading engineering firm, recently visited Vancouver in order to confer with Mr. Francis L. Swales, architect, regarding the installation of a power plant at the Hotel Vancouver. Mr. Beecher, who is a grandson of his namesake, the noted preacher, is associated in a business way with Mr. C. C. More, who was president of the Panama Pacific Exposition, and has wide business interests in Western Canada.

Obituary

Captain Gordon E. Blackader, 42nd Highlanders, of the firm of Barott, Blackader & Webster, architects, Montreal, is dead as the result of septic poisoning following an operation. Captain Blackader was recently reported as wounded.

Official announcement has been made that Lieut. A. W. McKnight was killed in action in France on August 11. Lieut. McKnight was a graduate of the Royal Military College at Kingston, and after his graduation was assistant engineer on the hydro project in the Kenora district. He afterwards went to Prince Rupert, and later became town engineer at Port Moody, B.C. When the war opened he immediately entered the engineers' corps. He was 27 years of age and was born in Owen Sound, Ont.

Albert E. McLeod, manager of the public utilities of Kenora, Ont., is dead, following an illness of three weeks from appendicitis. Mr. McLeod was in his 37th year. He went to Kenora in 1897 and engaged in mining and prospecting. Having an aptitude for electricity he joined the town staff in 1904 and showed such ability that on the resignation of Mr. Thomas six years ago he was appointed superintendent of the town's utilities, and two years ago was made manager of all the town's services.

Thos. J. Drummond, one of the most prominent representatives of the iron and steel industry in Canada, and a former president of the Montreal Board of Trade, died recently at Castine, Maine, where he was spending the summer. Mr. Drummond was a native of Ireland, where he was born in 1860, and was brought to Canada by his father in 1866. In 1908 he was elected president of the Canada Iron Corporation, and in 1909, of the Lake Superior Corporation, remaining at the head of that organization for several years.

Lieut. S. F. Weeks, 130th Field Company C. E., is reported as killed in action on July 11 in northern France. Lieut. Weeks was a native of England and was educated at London University, where he obtained his B.Sc. in engineering. He was articled to a consulting engineer in London and after working for a time on sewerage works he came to Vancouver and was appointed an assistant to the sewerage engineer in July, 1911. Immediately on the declaration of war he resigned his appointment and obtained his commission in the Royal Engineers.

Hon. Edgar Dewdney, former lieutenant-governor of British Columbia, died suddenly at his residence, 2840 Cadboro Bay Road, Victoria. He was born and educated in Devonshire, England, and immigrated to British Columbia in 1859, being employed by Sir James Douglas and Colonel Moody in the laying out of New Westminster. He spent many years practising his profession of civil engineer in building roads through the country, and was responsible for the completion of the Dewdney Trail from New Westminster to the eastern boundary of the province, in 1865. As a real pioneer of the province, his name will ever be associated with its history and development. He took an active part in all public affairs, and in 1869 was elected to the legislature. He was also a member of the House of Commons after Confederation, and was one of Sir John Macdonald's supporters. He was appointed Indian commissioner for the Northwest Territories in 1879, and later lieutenant-governor of that country, being called to the cabinet as minister of the interior and Indian affairs in 1888. He continued in office after the death of Sir John Macdonald until October 16, 1892, when he was appointed lieutenant-governor of British Columbia.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Bosanquet Township, Ont.
The Township Council have passed by-laws for a quantity of drainage work. Engineer, F. Menhennick, in care of George Sutherland, Thedford, Ont.

Brooke Township, Ont.
The Township Council are considering the raising of $10,000 for the construction of tile drainage. Clerk, W. J. Weed, Alvinston.

Caradoc Township, Ont.
The Township Council are considering the construction and repair of drains. Clerk, F. A. Lockwood, Mount Brydges, Ont.

London, Ont.
The City Council have authorized additions to the proposed storm sewers, which will increase the cost to $50,000 or $75,000. New plans are being prepared by Engineer H. A. Brazier.

Malden Township, Ont.
The Township Council have passed a by-law authorizing the borrowing of $10,000 for the construction of tile drains. Clerk, E. H. Brett, Malden.

Mitchell, Ont.
The Town Council have authorized the construction of sidewalks and curbing on Main Street and are considering the extension of watermain on Blanshard Street. Particulars from Councillor Walkom.

Moncton, N.B.
The City Council have decided to lay macadam pavement on St. George Street, and tenders will be called immediately. Approximate cost, $4,200.

New Glasgow, N.S.
The Town Engineer, E. S. Fraser, is preparing estimates of extensions to the waterworks. Approximate cost, $100,000. Town Clerk, J. Roy.

New Westminster, B.C.
The City Council propose to lay macadam pavement on Seventh Street, at an approximate cost of $4,200. Clerk, W. A. Duncan.

North Easthope Township, Ont.
The Township Clerk, I. D. Fisher, R. R. No. 1, Stratford, will receive tenders until 5 p.m., August 26th, for the construction of the Dahmer Drain. Engineer, John Roger, Mitchell, Ont.

Ottawa, Ont.
The City Council are considering the construction of a sewer on Booth Street, estimated to cost $5,700. Commissioner of Works, A. F. Macallum.

Richmond Hill, Ont.
James, Loudon & Hertzberg, Engineers, Toronto, have been instructed to report on the construction of a waterworks system, to include about four miles of pipe line, water tower, pumps, filters and storage basin. Estimated cost, $30,000.

St. Lambert, Que.
Tenders will shortly be called for the construction of trunk sewers on St. James Street, estimated to cost $17,000. Engineer, H. A. Gibeau. About 3,200 feet of cast iron pipe will be required.

St. Marys, Ont.
The City Council are considering the construction of a septic tank sewage system, estimated to cost $15,000. Clerk, T. M. Clark.

CONTRACTS AWARDED

Brampton, Ont.
The Town Council have awarded a contract for the construction of sewers to the J. H. McKnight Construction Company, Limited, 88 St. David Street, Toronto. Approximate cost, $11,000.

Hamilton, Ont.
The City Council have awarded the contract for construction of sewers on Gore Street to J. J. Armstrong & Sons, Burris Street, and for sewers on Mountwood Avenue to the City Engineer.

New Toronto, Ont.
The contract for construction of sewers for the Town Council has been let to R. C. Huffman, Mimico, Ont., at $43,878, and the contract for supply of pipe to Dominion Sewer Pipe Company, at $9,270.

Sault Ste. Marie, Ont.
The contract for construction of pavements on Gore Bay and Bruce Streets has been let by the City Council to the Warren Bituminous Paving Company of Ontario, Limited, McKinnon Building, Toronto.

Welland, Ont.
The Town Council have let the contract for construction of tarvia pavement on Burgar Street to McRae & Campaigne, Niagara Falls, Ont. Approximate cost, $14,168.

Railroads, Bridges and Wharves

Arkona, Ont.
The Town Council contemplate the erection of a steel and concrete bridge, and will shortly call for tenders. Clerk, J. G. Brown.

Bentinck Township, Ont.
Tenders on the construction of a cement arch at Hamel's Bridge will be received until 2 p.m., September 2nd, by the Reeve, George Brown, R. R. No. 4, Elmwood, Ont. Plans and specifications at office of the Hanover Post, Hanover.

New Toronto, Ont.
The Grand Trunk Railway are about to start work on the construction of a siding at Ninth Street. Engineer, F. Palmer.

Port Burwell, Ont.
The Department of Public Works, Ottawa, will receive tenders until September 8th for the removal of existing pier and construction of reinforced concrete block superstructure. Plans at office of the District Engineer, Confederation Life Building, Toronto, and at the Department. Specifications at office of MacLean Daily Reports, Ltd., 25 Charlotte Street, Toronto. Approximate cost, $30,000.

Vancouver, B.C.
The Canadian Pacific Railway are having plans prepared for the construction of a jetty pier at an approximate cost of $1,000,000, and work may start very shortly. Engineer, Frank Lee, Winnipeg.

Wainfleet Township, Ont.
Tenders on the construction of seven concrete bridges will be received until August 26th by the Township Clerk, J. Henderson, Marshville Post Office. Plans with the Reeve, James Lorraway, R. R. No. 3, Welland.

Wingham, Ont.
The Town Council have passed a by-law authorizing a debenture issue of $3,000 for the construction of a concrete dam. Engineer, H. Campbell.

CONTRACTS AWARDED

Lorne, Man.
The Municipal Council have awarded the contract for substructure of a number of steel bridges to William Newman Company, Ltd., 409 Ashdown Street, Winnipeg, and the contract for superstructure to the Canadian Bridge Company, Ltd., Walkerville, Ont.

Saskatoon, Sask.
The Board of Highway Commissioners, Regina, have awarded the contract for laying pavement on the bridge at Twenty-fifth Street to the Bithulithic and Contracting Company, Ltd., 10047 One Hundred and Fifth Street, Edmonton, Alta. Approximate cost, $26,000.

Sherbrooke, Que.
The City Council have awarded the contract for construction of a concrete dam to T. L. MacBean & M. L. Williams, 29a Belmont Street, Montreal.

Ste. Rose Du Lac, Man.
The contract for steel work required in the erection of a bridge has been let by the Municipal Council to the Algoma Steel Bridge Company, Ltd., 824 Union Bank Building, Winnipeg, and the cement work to E. L. Pilgrim, Dauphin, Man. Approximate total cost, $8,000.

Public Buildings, Churches and Schools

Campbellton, N.B.
The architect for the school which the School Board propose to erect on Gerrard Street is F. Neil Brodie, 42 Princess Street, St. John. Brick construction. Estimated cost, $12,000.

New Glasgow, N.S.
The time for receiving tenders on al-

ESTABLISHED 1886

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A Central Concrete Mixing Plant

CONCRETE as a building material is peculiar, in that it is manufactured and fabricated in its entirety from the raw state right on the job. It differs in this respect from steel, wood, or brick, the other principal building materials. The fact that concrete is made at the place of construction means that each job has its own plant, its own supplies, its own labor, and its own inspection force. This seems true whether the work involved is large or small or whether much concrete is required or little. There is apparently so much waste in these conditions, so much unnecessary duplication, and so much loss of time that it is not out of place to search for a remedy that will eradicate these objections. When concrete is compared with other stable materials of construction the question is naturally asked: Why cannot concrete be made at a central plant and distributed as required? Why can it not be sold already mixed and ready for placing? We believe this method is quite applicable—within certain limitations, perhaps, that experience and experiment will dictate. At any rate, if such a system were found suitable there is no doubt but that the objections of the present methods would, in large measure, be overcome. The elimination of wasteful efforts, of multiplication of equipment, and of individual inspection, would alone seem to justify its inception. A product of higher quality and of more uniform and homogeneous texture could unquestionably be obtained. At the same time the reduction of cost on a basis of quantity production would be an important item, while the saving in space and in time on individual jobs would amply warrant its trial.

Of course, in instituting a reform of this nature there is the bond of conventionality to overcome, the spirit that moves concrete users to swear by old methods and antiquated ideas. Yet we cannot help but feel that a little education would soon persuade builders to acknowledge the possibilities of the scheme. Technical points, however, would probably be the most potent obstacles to successful operation.

* * *

The question of delivery would seem to be the perplexing problem. The point is: How far can the product be delivered from the point of manufacture without developing a certain amount of set? Delivery would have to be by motor truck to cover in a short time a field sufficiently large to be commercially feasible. Investigation has shown that the jiggling attached to motor truck transportation prevents any material decrease in strength due to initial set for periods up to an hour and a half, so that, using this time as a basis, it is evident that a wide district could be served from a central concrete plant. Of course, delivery must be absolutely certain to make the plan a success. Arrangements would have to be made to ensure a contractor obtaining his material when he is ready for it. This, perhaps, is where the individual mixer has an advantage. It is ready to supply at any instant, provided materials are stocked.

Just such an installation was instituted last year in a United States city, which experienced certain measures of success, although hampered by insufficient capital and to a certain extent the antagonism of smaller contractors. However, the project was completely successful in so far as its product was concerned, and many new uses were developed for the employment of pre-mixed concrete. A city regulation required delivery of the material to take place within 30 minutes after mixing, all concrete arriving after that time to be rejected. We understand that this experiment has developed many features that presage much success for a working plant of this nature.

* * *

This matter is open to a great deal of discussion because the exact method of procedure is doubtful. There is no precedent to fall back on; no basis of experience from which to judge of its feasibility. So far as we see, the easiest way of effecting a solution seems to be for the jobbers—those who now supply the sand, cement, and gravel—to operate the central mixing plants. They would be able to obtain the raw materials as before, and the only difference would be that they would be selling concrete in two forms instead of one—mixed as well as unmixed. They would be able to supply contractors and builders with comparative prices for concrete delivered at the site either ready for placing or as separate components. In this way the contractor would get an idea of the relative value and costs of the two methods and could choose the less expensive.

We believe that this subject presents wide possi-

bilities. Whether it is feasible or worth while is open to debate; whether it will pay profits and stand the competition of mixing on the job requires investigation. There seems, however, in the scheme sufficient inducement to encourage belief in its ultimate success. We trust that some discussion will be evoked as to its reasonableness and effectiveness.

The Street Opening Evil

THE street opening problem is one of the most perplexing questions with which municipal authorities have to deal. Reduction of the number of such openings, the elimination of unnecessary ones and effective control of those that are required, are matters that are being considered by roadway engineers and municipal authorities, not only per se, but also because they involve broad questions relating to the planning and maintenance of highways. One of the most frequent and persistent points of criticism is in regard to openings in street pavements. Citizens are annoyed at the apparent frequency with which streets are torn up, and more especially they rail at the authorities for the manner in which brand-new pavements are seemingly taken up as soon as laid, to make way for a public utility connection. In such a case city authorities are blamed for not properly anticipating the needs of that street. The conventional method seems to be to lay all subsurface structures, in so far as their use can be anticipated, before paving or repaving. This underground construction is located in the roadway and service connections are provided for such buildings as then exist. Later comes the demand for additional service connections, the laying of new utilities, and repairs or enlargements to structures.

Although there is too much tearing up of street pavements, the absolute elimination of such is impossible to effect, because it is beyond the field of possibility to exactly predetermine the future growth or requirements of a community; and, even in older and more settled localities, the installation of new services, their enlargement to meet increased demands, or their change to follow advanced practice or design means that street openings are necessary. The problem is thus not one of preventing the tearing up of pavements, but resolves itself into finding a means of reducing the number of openings to a minimum.

City planners have been giving much thought to the matter, and many methods have been suggested for the abatement of this nuisance. Attempts have been made to absolutely prohibit by legislative action any openings being made in a new pavement for a specific number of years, but, although it is desirable to keep such roadways intact, experience has demonstrated that legislative methods are futile, in as much as it is against good public policy by hindering development of adjoining land. Pavement construction in new streets stimulates the development of adjacent property and the erection of new buildings, which require installations of utility connections. It is impossible to force owners of land to build before streets are improved. Uncertainties of municipal management make them prone to delay building until grade and road improvements are made. For this reason legislative action is opposed to the best interests of a city's development.

We believe that by exercising proper care and foresight new streets can be planned so that underground connections may be installed without disturbing the road surface. At very little trouble or expense service pipes can be laid beneath the sidewalk and duplicated on each side. The extra cost will probably be balanced by shorter connections and the elimination of roadway openings.

In congested and closely-built-up business districts a solution of the difficulty is harder to find because the ground is usually so much occupied with the multitude of existing pipe lines, underground galleries and tunnels. There is no doubt, however, but that the matter can be solved in some practical and efficient manner.

The present method of controlling and regulating street openings differs in many respects in the various cities. It is a problem to which the correct solution is as yet undetermined, but, as we have pointed out, the absolute prevention of street openings is impossible to effect, so that the only alternative is to take measures that will insure proper planning and work and thereby reduce the evil to a minimum.

Rapid Concrete Construction

A REMARKABLE and perhaps unequalled construction performance was the recent completion in record time of a factory for the Baldwin Locomotive Works, Philadelphia, Pa. The outstanding feature of this building was the rapidity with which the work was carried on. On May 20 the foundations were completed and by June 30 the reinforced concrete frame was completed for the entire structure, 8 storeys high, 100 ft. x 400 ft. in plan. Omitting the days on which no work was done, it means that the actual working time was 25 days, which constitutes an unapproached record for reinforced concrete construction.

Everything was specially designed for speed, as the building was required for munition work, and arrangements were made so that there would be as little hindrance as possible to quick handling of materials. In all, 15,000 cubic yards of concrete were poured, exclusive of 5,000 cubic yards in the footings. One floor in particular, incorporating 1,700 cubic yards of concrete and measuring 40,000 square feet in area. was completely formed and poured in something less than three days.

All storey heights were made uniformly 12½ ft. high and all floor panels were 20 ft. square. As above ground building was faster, no basement was made, and no expensive or unnecessary architectural effects were employed. The flat slab floor system was used, eliminating the use of more or less complicated beam forms. Attempts were made to have all forming as regular and uniform as possible. Practically the only sizes of lumber handled were 4 in. by 4 in. and 1 in. tongue-and-groove, so that no odd sizes were carried, and storage and handling were on this account much simplified. One million feet B.M. were used altogether for this purpose. Four complete floors of slab forms and one set of column forms were furnished. Flooring centering was removed in 14 days and column forms in 24 hours.

Two towers, 190 ft. and 125 ft. high respectively, were used for raising and distributing the concrete. There were also two brick hoists and derricks for raising the reinforcing and form work. The concrete was poured from one end of a floor to the other. When one half of a floor was six hours old the carpenters would begin erecting the centering of the next floor, and the reinforcement would be placed. The form work was continued as the second half of the lower floor was laid and had a chance to set. The two towers at opposite ends facilitated the placing of concrete simultaneously on the two different floors. The speed of construction was helped by using concrete blocks to support the reinforcement and by employing high

runways on wooden horses, laid out so that no concrete was carted over finished floors.

All materials were handled from the streets, most of them being delivered in five-ton motor trucks. Delivery was carefully planned and timed so that, when no storage was provided, the material could be taken to the required place and used as soon as it reached the job. The bending of steel was done by hand as each load came in before stacking. The concrete plant, stone and sand elevators worked 24 hours per day continuously, with Sundays off for repairs and overhauling.

A thousand men were used on the job altogether, working in shifts, so that operations were carried on continuously night and day. With the exception of the brick elevators, which were steam operated, all equipment was electrically driven.

"Safety First" on Public Highways

The provision of greater factors of safety on public highways is recommended by H. E. Bilger, road engineer of the Illinois State Highway Department, in a paper presented at the Kansas conference in highway engineering. The special points advocated in this paper are a realignment of highways at sharp curves, cross roads and railroad crossings, a larger radius at curves, ample passing room, and level approaches at railway crossings. Some paragraphs of this paper are extracted in the following:

The alignment that, fifteen years ago, satisfactorily met the requirements of a maximum speed of eight or ten miles per hour cannot suffice, with any reasonable degree of safety, for the present traffic conditions that impose a speed of from twenty to forty miles per hour upon the highway. The present conditions are such as make imperative that, in all highway improvements, this matter be given serious consideration, and in view of the increasing density of the high-speed traffic it becomes advisable that due attention be paid to probable future traffic developments.

Without in any way interfering with the economics of highway location, there can be effected, even in the details of the work, a marked improvement in the general comfort and safety of the travelling public. For example, at all abrupt angles in the right-of-way, and particularly those approaching 90 degrees, an improvement can be brought about by simply procuring the necessary additional right-of-way to permit moving the inner fence corner a distance of some 75 feet or more. By so doing the radius of the curve can be considerably lengthened and a much better view provided, to the end that public travel is benefited out of all proportion to the cost of the little triangle of land. In order that this additional right-of-way at the corner may be utilized to the utmost, it is necessary that all vegetation be kept down and that the signboards, if any, be transferred elsewhere.

At all cross-roads additional land should be provided by moving the fences back to include within the limits of the right-of-way the four triangles at the corners. This greatly enhances the view in all directions by bringing the control of the corners within the authority of the road officials, thereby arresting the growth of vegetation that obstructs the view of highway travel.

In the vicinity of railroad crossings the improvement of the highway should be such as to provide an unobstructed view along the track for at least 1,000 feet each way. This view should be enjoyed along a length of the highway extending for at least 300 feet on each side of the crossing. At the crossings it is particularly important that sufficient accommodations be provided to permit two vehicles to pass with entire comfort and safety, requiring never less than 18 feet, and the highway for some 50 feet or more on each side should be practically level, or should at least have a very easy grade, say not steeper than about two per cent.

Auxiliary Steam Plant for Granby, B. C.

The Taylor Engineering Company, of Vancouver, consulting and contracting engineers, are at present building at Anyox, B.C., for the Granby Consolidated Mining, Smelting and Power Company, an auxiliary steam plant to supplement the Granby company's present water power plant, which has a normal capacity of approximately 7,000 h.p.

The new auxiliary plant will be housed in a reinforced concrete building, 98 ft. x 88 ft. x 37 ft., and the equipment for the plant will consist of five 550 h.p. water tube boilers arranged for oil fuel; a 3,000 kw. and 2,000 kw. Westinghouse turbo-generator; a 100 kw. Westinghouse exciter; a 3,500 ft. 100-lb. pressure De Laval turbine-driven centrifugal compressor driven at the one end by an 800 h.p. Westinghouse motor, also through reduction gears. This unique arrangement has been adopted so that the compressor could be operated by motor in the summer time if it is decided not to operate the steam plant.

The boilers are served by a Custodis radial brick chimney, 10 feet in diameter and 150 feet high.

The power house building is nearly completed, and most of the foundations are in place, ready to receive machinery. Complete engineering details will be available later, when the plant is finished.

The entire plant has been designed by the Taylor Engineering Company, under the direction of Mr. F. M. Sylvester, managing director of the Granby Consolidated Mining, Smelting, and Power Company.

The approximate cost of the completed plant is $600,000, and it is expected that the largest proportion of the plant will be in service by the end of the year.

Carrying Water 181 Miles

A water supply system is being constructed for the city of San Francisco, to have an estimated cost of about $44,000,000 and to be completed during the next eight years. It will be brought 181 miles from the Hetch Hetchy Valley, and will supply 400,000,000 gallons per day. The capacity of the aqueduct is not as large as that of the Catskill aqueduct in New York, but its length is much greater. Two million, two hundred and fifty thousand dollars have already been expended, and contracts have been let for about another two million dollars of work for this year. During this season a construction railway, diversion tunnel, and diversion dam and foundations for the main dam will be built, and a temporary hydro-electric power plant will be installed, at a cost of $120,000.

The Department of Trade and Commerce, Ottawa, have issued a memorandum regarding the National Trade and Commerce Convention, prepared by F. G. McAllister, B.A. This is an outlined plan of the preparations being made for a national trade and commerce convention, to which the Right Hon. Sir George Foster, Minister of Trade and Commerce, will call the business interests of the Dominion some time during October.

Canadian Municipal Officers in Convention

Discuss Ways and Means for Greater Efficiency in Organization, and in the Construction and Maintenance of Public Works.

For the first time since the commencement of the war the Union of Canadian Municipalities held their annual convention in Montreal on August 21, 22, and 23. The previous convention in the same city was in July, 1908. The papers read covered a very wide range of municipal activities, the effect of the war upon Canada, particularly in relation to its development after the cessation of hostilities, being freely discussed.

At the opening of the convention, over which Mayor T. L. Church of Toronto presided, the delegates were welcomed by the Mayor of Montreal. Replies were made by Dr. Stevenson, Mayor of London; Mayor Hardie of Lethbridge, Mayor H. Cater of Brandon, A. McG. Young, Mayor of Saskatoon; Alderman Ryding of Toronto, Mayor Sylvestre of Sherbrooke, and ex-Controller Spence of Toronto.

The president's address was full of interest, as may be gathered from the following quotations:

"The need of connected effort by municipalities to protect municipal rights was never more apparent or more necessary than during the last session of the Dominion and provincial parliaments. Unfortunately, when legislation affecting the municipalities is being considered, there are always to be found in Canada's parliaments some representatives of the people who invariably take a stand against our rights on almost every occasion. We are confronted with powerful lobbies, and it is a deplorable thing to think that the municipalities have to fight as they have to secure their rights.

"There was never a time when there was more for the Union to do than at present. Companies which could not obtain provincial or municipal charters went to Ottawa last session and secured them there, and had legislation passed, as in the radial fight, which upset the rights of the municipalities."

Regarding the financial situation, he said that it paid the municipality to have a first-class treasurer. Toronto had a new one, and had to pay $15,000 per annum. There was one great weakness in the Canadian system of municipal government, and that was the small salaries paid to competent men as heads of the departments. The municipalities of the country had been served by men of marked ability as heads of departments, and it was a deplorable fact that these men had been badly paid. Thomas Bradshaw, the new Toronto city treasurer, the first day he was with the city saved his salary of $15,000 in floating some treasury notes. Some of the best heads of the departments of municipalities had been taken by private ownership, owing to the poor salaries paid.

The time had come for the municipalities to put the brakes on regarding capital expenditures. Various governments of Canada were doing this. No capital expenditures should be incurred in war time except for actual essentials, and any unnecessary work should be cut out. The credit of the municipalities of Canada generally was a matter of congratulation, but they should be very careful in time of war not to add to the capital debt.

Mr. W. D. Lighthall, K.C., honorary secretary-treasurer, gave a review of the activities of the Union since the war began, and told how a return of prosperity to Canada because of bountiful crops had changed a situation for which the municipalities and the Union were trying to find a solution.

The financial report for 1915 of Mr. G. S. Wilson, assistant secretary, showed a balance of $305.41 on hand, after an expenditure of $5,272.98. He pointed out the necessity of a larger revenue.

The Town Planning Outlook in Canada.

"The Town Planning Outlook in Canada" was the subject of a paper by Mr. T. Adams, town planning adviser to the Commission of Conservation, Ottawa. In the course of his paper Mr. Adams said maladministration in municipal and social affairs can lead to greater monetary loss to the taxpayer than equivalent administration in national affairs. From the point of view of conservation of human and natural resources the power for good or evil of local government is greater than the power of national government. In the losses of a great war we are reaping the reward for our sacrifice in greater strength of soul, but in the loss due to social neglect and inefficiency we can only reap the reward of decay.

"If we had employed more science and foresight in the planning of our cities and towns we would not have permitted unhealthy land speculation. It is difficult to realize the possibility of a return to the high level of land values, coupled with higgledy-piggledy development, which predominated in Canada three years ago. Still more difficult it is to conceive that our municipal bodies will permit the speculation which caused these values without proper regulation. One direction in which we want more expert knowledge is in regard to land valuation. It is true that a system of planning, of assessment, and of taxation which encourages high land values is economically unsound. Then there are all the indirect effects of the absence of town planning and the presence of speculation. They not only increase the direct tax for using the land, but cause waste of its expenditure. Water supply, sewerage systems, lighting, transportation cost more when they serve large areas of vacant frontages. In many cases development is so scattered that we not only lose interest on our expenditure on local improvement, but the whole of the capital cost or more in depreciation and extra cost of equipment, and the same consideration applies to street pavements or sidewalks. The financial burden now being caused in many cities by this widespread development has become a serious trouble. Next to overcrowding, one might also say that the worst financial evil in the city is undercrowding—that is, when the undercrowding is taking place without a plan. But overcrowding and undercrowding are usually complementary, for we encourage both by lack of planning.

"With regard to parks and playgrounds, that, too, is merely a question of proper planning. The town planning outlook in Canada at present, so far as the principles on which it is based are concerned, may be summarized as follows: First, we must plan to build up a more scientific form of government, and now is the time to lay the foundation. Second, municipal administrations control greater financial interests and matters affecting public health than any other kind of

administration. Town planning which deals with the proper regulation of the use and development of land for building purposes is the most vital matter affecting these financial interests and the health of the people. Third, we want more respect for those who administer municipal affairs, but that will only come when municipal administrators have more respect for themselves and for their expert advisers. Fourth, the land system is at the root of our municipal problems, and we need town planning in unison with the same system of valuation and assessment to provide us with a better basis for the future.

"The outcome in regard to actual progress in applying these principles in Canada is most encouraging." After giving particulars of town planning in other countries, Mr. Adams proceeded: "In Canada we are improving all the time, and in a more general and scientific way than in the neighboring republic. Our town planning legislation is being taken as a model in the South, and the time has come for us to be the originators instead of the imitators. In Nova Scotia we have advanced legislation, with certain compulsory features, under which Halifax and other cities and towns, and even rural municipalities, are proposing to prepare schemes. In New Brunswick, St. John is preparing a scheme for 20,000 acres. The matter is also being taken up in Prince Edward Island in connection with agricultural development. In Quebec there is no general legislation in force, but the need of it is now recognized, and several cities and towns have petitioned for it. The same applies to Ontario. There is partial legislation dealing with town-planning problems in both these provinces, but urgent need is felt for a comprehensive act. Further west we have a good act to enable authorities to prepare schemes. An act has passed its first reading in Saskatchewan. In Alberta the use of the Act of 1912 is now being considered because its value in enabling cities to properly regulate real estate development and in preventing the financial troubles which inevitably follow from widespread haphazard suburban development is only beginnning to be properly recognized. There is an urgent call for legislation also in British Columbia.

"I have just completed a tour from the east to the west. Town planning is now looked upon in every province I have visited as a sane and common sense proposal to give local authorities the needed power to properly control their future growth and to avert the possibilities of financial disaster. Vancouver, Victoria, Edmonton, Calgary, Medicine Hat, Swift Current, Regina, Saskatoon, Winnipeg, Fort William, Port Arthur, Toronto, Hamilton, Renfrew, Brantford, Berlin, Ottawa, Kingston, St. John, and Halifax are a few amongst those which are most active in the matter outside of Quebec. In Ottawa the scheme has been promoted by the Federal Government, and is not of the kind that can be imitated and carried out by an average city. What we want is legislation that will add to the powers of our municipalities to deal more effectively with future growth, at the same time setting up machinery to enable the province to be of more effective use in advising and helping the municipalities and in securing co-operation between those whose interests overlap or whose boundaries adjoin.

"It is only possible to give brief summary, but I hope I have said sufficient to enable you to appreciate the advisability of our completing the link of town planning from coast to coast. I have no fear that that link will not be completed, either, to the east of Quebec or the west of Ontario, but your help and counsel is needed to get the two largest provinces in line with the others. I hope you will petition British Columbia, Ontario, and Quebec to follow the lead given by the other provinces. You may rely upon the co-operation of the Commision of Conservation in giving effect to that legislation when it is passed, because we not only believe that we must in Canada today conserve human life and promote social ideals, but that the most needed thing to accomplish that task is to lay a scientific and economically sound basis for our municipal government and development."

Discussion.

Mayor Church took exception to the suggestion that local government boards of experts should be formed in the various provinces to pass upon legislation of various kinds enacted before the municipalities inside the provincial boundaries. He did not believe in the appointment of a commision by the province for that purpose. "Some of the provinces should fix their own affairs first before trying to show us how we should manage ours. Some of them are the laughing-stock of the Dominion for the way in which they are handling their business. The larger municipalities want autonomy. Canada is the most over-governed country in the world. There is no necessity for provincial governments at all in my opinion. They have not got them in England, Scotland, Wales, or Ireland. They don't have them in other parts of the Empire. We are over-governed, and the cost of government is continually going up. There is no need of provincial commissions for the larger cities. Toronto is burdened to death with provincial commissions. The municipal government of Canada, when placed side by side with provincial parliaments, will compare very favorably from the standpoint of business efficiency. I am of the opinion that town planning should be taken up by the municipalities which have secured their autonomy, and not through the interference of government commissions. The key of sound municipal government, as of everything else, is to have good heads of departments, pay them well, give them free hands, make them responsible, and let them appoint their own subordinates. Mayors and councils come and go, and they have a mere temporary effect."

Mr. Adams replied that such a commission of experts would be invaluable to the many small towns throughout the country who could not afford to pay the high salaries that the larger cities did. The forming of a local government board would prevent small municipalities making greater mistakes for lack of experience, and it would give valuable expert advice to every small municipality in the matter of floating loans.

In the course of further discussion most of the speakers judged that there was not much difference between Mr. Adams and Mr. Church, both wanting the same results by different methods.

Other Papers.

At the evening session papers on the patriotic fund, immigration, proportional representation, and municipal responsibility in Canada's preparedness, were read. The latter, by Mr. Fred Wright, suggested that the councils should prepare for the re-employment of the great army of munition workers after the war and also the thousands of returning soldiers. In discussing "Public Employment Offices," Mr. B. M. Stewart, chief statistician (Federal) Department of Labor, Ottawa, eulogized the British system of labor offices. He pointed out that in addition to cyclical fluctuations of labor there were seasonal variations. Because of our climate we did comparatively little building in the winter, and large numbers of building tradesmen found themselves

out of employment in the winter season. A well-organized system of labor exchanges could do much to overcome these seasonal fluctuations. They could assist workers, such as building laborers, to take up logging and ice-harvesting, and to secure some of the less skilled work in factories. He suggested that the larger cities of each province unite with the provincial governments to establish labor exchanges, and they might ask the Federal Government to federate men into a national system.

Mr. J. Duchastel, engineer of the city of Outremont and president of the Good Roads Association of Canada, read the first paper at the session on August 22. This appears in full elsewhere.

In a paper on the new model charter of the National Municipal League, Mr. Clinton R. Woodruff, secretary of the National Municipal League of the United States, outlined the chief points of the charter. Its whole character, he said, was in the direction of making government by experts feasible and possible. The model was assumed to be a municipal home rule charter. The city was given power to conduct its business without having to refer constantly to the state and provincial legislatures so to do. The city manager was the chief officer. selected solely on the ground of capability. All the heads of the civic departments were to be qualified for the particular work. Thus the public works department would be controlled by an engineer. All the heads of departments were responsible to the city manager.

At the afternoon session Mr. Thomas Bradshaw, commissioner of finance and city treasurer, Toronto, read a paper on "A Study of a City's Sinking Fund." Mr. Bradshaw's paper is printed on another page of this issue.

Introducing Modern Systems.

"How Best to Introduce Modern Systems of Municipal Work" was dealt with by Mr. H. L. Brittain, managing director Bureau of Municipal Research, Toronto. There was, he stated, no possibility of establishing what could be termed the best form of municipal government. Each government must be suited to different kinds of people. The most important thing was to establish a form of government which would do the most effective work. Mr. Brittain urged the importance of securing reliable data which would enable good government to be given and to locate where the leakages were. Most of the losses in municipalities were not due to rascality, but to the lack of information leading to ill-advised enterprises.

During the afternoon the Hon. R. Rogers, Minister of Public Works, addressed the delegates. His remarks were chiefly devoted to the statement of the munitions board, that Canada was behind-hand in the deliveries of munitions. He asked that those men who were capable of remedying this serious condition should do so. He also asked that Canada should prepare for the great developments which were bound to occur after the war. The Dominion had enormous resources, and she should so utilize these as not to be dependent upon outside countries as she had been in the past. All classes ought to combine with a view to securing increased immigration. Canada possessed immense possibilities, and ought to be able to attract a largely increased population to her shores.

Mr. E. T. Sampson, secretary-treasurer of Outremont, read a paper on "Municipal Accounting."

Apart from a paper on "Municipal Assessment," by Mr. R. Ryan, chairman of the Finance Committee, Three Rivers, P.Q., the evening session was devoted to several papers on administration. These dealt with various forms of local government, from the purely aldermanic to managership. The discussion favored some description of control, although naturally there were various modifications advocated. There was almost complete accord in the view that expert administration is now the only possible economical method of governing our cities and towns. The day of amateur administration is passing, and to get efficient service the various cities must rely on experts at the head of the many departments of civic activities.

The only advocate of the purely aldermanic form of government was Alderman E. Lariviere, of Montreal, who contrasted the administration under that regime and under the present mixed method of aldermen and controllers. The latter, he declared, had failed; debt had been doubled, the annual expenses materially increased, and, generally, the city had not progressed under the management of controllers, due in a measure to the impossibility of controllers dealing satisfactorily with the enormous amount of work. In his opinion, a mayor and one body, by whatever name called, was the best form of government.

The Lethbridge System.

Mayor Hardie, of Lethbridge, described the system of commissioners in that city. They were, he said, elected by the people for particular offices, the government being vested absolutely in their hands. The commissioners were subject to recall, the referendum and preferential vote being also authorized. The system had worked very satisfactorily, and was a decided improvement on the old one of aldermen.

Controller J. W. Nelson, of Ottawa, spoke of the board of control in the federal capital. There had been some alterations in their system, which now consisted of aldermen and controllers, and which had been the means of successfully carrying on the administration. The only drawback was that of annual election, which should be replaced by a two years term of office.

Mr. P. W. McLagan, Westmount, traced the history of the managership method. He commented upon the defects of the commission form, and contended that managership was an improvement upon the former as generally carried. The chief defect of the commission system was the selection of untrained men, his view being that to obtain good results experts must be appointed by the council. The manager must be trusted with the selection of his subordinates. He was of the opinion that the very best results could be secured from the manager method, but it was essential the men should be well paid. Municipal corporations should follow the example of large utility companies, and appoint men who understood their business. While he believed the managership was the best way of governing cities and towns, he did not guarantee it to be either fool or graft proof. The experience of Westmount was very satisfactory, and they were fortunate in appointing Mr. G. W. Thompson from their own staff as manager. Westmount owned its own electric lighting, and had the best incineration plant in Canada.

Ideal Form of Government.

In a very elaborate paper, Mr. Yorath, C.E., City Commissioner, Saskatoon, sketched what he considered an ideal form of civic government and administration. This consisted of two aldermanic committees, with an experienced and expert manager. The form of civic government in Great Britain had met with fair success, chiefly because of the ability of the permanent officials; there was, however, a lack of co-ordination between the departments. The Canadian system was largely moulded on United States lines, the great de-

fect of the Board of Control method being the selection of unsuitable men. Mr. Yorath criticized the purely aldermanic plan, it being ridiculous, he asserted, to expect good government from men largely without experience. He suggested that election of any representatives should be by proportional representation. The appointment of provincial bodies similar to the Local Government Board in England would, he thought, be an excellent thing. Municipalities were largely responsible for the national fire waste, as the drawing up of the building by-laws was in their hands, and in many instances these by-laws were far from efficient.

Mr. J. N. Bayne, Deputy Minister of Municipal Affairs, Saskatchewan, at the session on August 23, detailed the functions of this department of the province. It was established to give advice to municipalities, particularly in the matter of monetary by-laws. The general action of the department tended to uniformity in municipalities. The province also had a local government board.

The executive committee was remoulded in the form of the appointment of the chief officers and the first vice-presidents of the various provinces.

Victoria, B.C., will be the next meeting place of the Union.

The election of officers resulted as follows: Honorary president, Mayor T. Church, Toronto, Ont.; president, Alderman Leslie H. Boyd, Montreal, P.Q.; first vice-president, Mayor Alex. Stewart, Victoria, B.C.; second vice-president, Mayor H. Stevenson, London, Ont.; third vice-president, Mayor W. D. L. Hardie, Lethbridge; honorary secretary-treasurer, Mr. W. D. Lighthall.

Some Remarks on the Benefits of Good Roads

By J. Duchastel*

No community has ever regretted the improvement to its roadways. I believe that I will not find anybody here to contradict this statement. It may be that in some cases, roadway improvements have cost the community more money than they should, or that they have not been of a sufficiently permanent nature to meet local conditions, but these are mere accidents which have nothing whatever to do with the benefits generally derived from improvements to roadways.

In a country like Canada, there is no form of natural development of greater benefit to the people at large than road improvement, and the reason for this is very simple. The public road or highway is of all forms of intercommunication, the only free one, and also the most universally used. It is therefore very important that this question of road improvement should be one of the principal problems before the mind of the leading citizens of any community.

The benefits derived from good roads may be grouped under two headings, viz:—(1)benefits of an economic order and (2) benefits of a social order.

Economic Benefits

It is very hard indeed to single out the benefits derived by one class of the community without treating of the advantages common to all. The advantages gained by the farmer are bound to have a favorable influence upon the city dweller, and vice versa. The people have got on very well for centuries without the merchant, the manufacturer, or the professional man, and very likely could manage without them again. But what about the farmer? What about the man who raises the crop we require to keep starvation away from our doors? We all know that we cannot do without this man, and we feel that by making him happy and prosperous, we are doing our own selves a great favor. I will, therefore, with your permission, diverge from the title which has been assigned to me, and treat upon the benefits derived from good roads generally.

The majority of the people in any locality are in favor of road improvements; nevertheless, there is always a certain element, more or less important, depending upon the degree of intelligence—or possibly foresightedness and progressiveness of the locality—that worry a great deal more about the burdens that accompany road improvements than about the results obtained through them. It should be our object, as it is the object of the Dominion Good Roads Association, which I have the honor to represent here to-day, to reach this timid element and show them that, while these burdens may be large, if properly distributed over a series of years, and if the proper type of road improvement has been selected, they will be comparatively small for each individual to carry, and moreover, the direct saving due to these improvements will, in a short period of years, pay for the capital and interest invested therein.

There are a few axioms in connection with road improvement, which need no other comment, and which I would like simply to enumerate to you right here:

Road improvement is fundamentally an economic problem.

Poor road surfaces are an economic waste.

Good roads are the primary cause of the increase of property values.

Paved streets are necessary assets to draw residents and business to a municipality.

Good roads considerably reduce the cost of haulage.

Good roads bring the producer closer to the consumer, and the result is a decrease in the cost of living.

Good roads permit the farmer to bring into town fresher and more wholesome foodstuffs the whole year round.

Good roads tend in a large measure to keep the people on the farms.

Good roads attract the tourist trade, which is becoming more important every year.

Clean and dustless streets are a sure preventive of disease.

Now the problem before us is to determine the best ways of deriving these benefits.

Let us review the different methods of improving roadways, which are generally classified in the following manner:—(1) betterment of the road surface; (2) reduction of grades, and (3) shortening of the road itself.

Betterment of the Road Surface

It is hardly necessary for me to insist upon the benefits derived from the betterment of road surface.

* President of the Dominion Good Roads Association

You all have noticed in your own town, the favorable influence on business and the increase in real estate values such improvements bring with them. Allow me simply to point out the influence road surfaces have on haulage in general. I may quote in this connection, some of the experiments made by the United States Department of Agriculture in connection with loads a horse can draw in an ordinary wagon over level roads of different kinds and in different states of repair:—

On a muddy earth road, the maximum load is 800 pounds.

On a smooth dry earth road, from 1,000 to 2,000 lbs.

On a gravel road in poor condition, from 1,000 to 1,500 pounds.

On a gravel road in good condition, up to 3,300 lbs.

On a macadam road, from 2,000 to 5,000 lbs.

On a brick road, from 5,000 to 8,000 lbs.

These figures, I consider, are very eloquent. They certainly speak for themselves. They show conclusively that a horse travelling at the same speed will haul on a macadam road, without any greater effort, from three to five times the load he will haul on a muddy road; and that on a brick road in good condition, and on any other smooth pavement, about twice the load he would on a macadam road.

It is established that the cost of hauling one ton one mile is fifteen cents more in America than in Europe, independently of the difference of wages that may exist. The average load for farm products is about nine miles. Now, according to these figures, which are conservative, the farmers of this country would save from $4,500,000 to $5,000,000 a year if we had a system of roadways equal to those in Western Europe. Do you realize how far half this sum would go to pay interest and sinking fund charges in connection with road construction and improvement in this country?

People are generally very quick to protest against any increase in freight rates charged by railways, but they always fail to grasp the importance of the saving they can make by having good roads. In the past eighty years, freight rates have been decreased nearly ninety per cent., but taken as a whole, the reduction on cost of highway transportation has been nil.

Reduction of Grades

The question of grades is also a very important economic one. It is quite true that in cities, towns and villages, it is practically impossible in most cases to modify any bad grades, on account of the damage that might be caused to the bordering property-holders and the heavy costs they are sure to claim through the courts; but in town planning or in the opening of new city districts, the question of grades should be looked into very carefully and settled according to well established engineering rules.

It has been established that a horse of, say, twelve hundred pounds will, by exerting a force equal to one-tenth of his weight, draw a load of two thousand pounds on a level road; on the same road built on a five per cent. grade, with the same force against his collar, he will draw one thousand pounds, and on a seven per cent. grade, only seven hundred and fifty pounds. What is true in connection with the horse-drawn traffic, is equally true, and probably more so, in the case of the mechanical-drawn traffic.

Another important feature of this question of grades is the fact that steep grades are more detrimental to haulage on improved roads than on unimproved ones, and this is due to the fact that the tractive resistance on improved roads being low, the grade effect will be proportionately greater in the first case than in the second. Steep grades are slippery and dangerous in cold weather, hard to maintain, and their surfaces are easily washed away in stormy weather.

Steep grades generally come about in urban municipalities on account of the desire of land speculators to lay out their roads and streets along lines parallel to straight boundary lines, trying in this manner to get out of the subdivision every available square foot of land. We have some very sad examples of these poorly laid out streets in some of the most beautiful districts on the Island of Montreal, and unfortunately, this state of affairs cannot be remedied, on account of the high sums of money it would require. What is more pleasing than curved roadways, and ascending slopes of a gentle grade? One sees fine examples of what I mean in the Rosedale District of Toronto, along West Crescent Heights in Westmount, or Cote St. Catherine Road in Outremont. There should be a law in this province establishing the maximum grade of roadways and streets, as there is a law fixing the width of streets.

Re-Location of a Road

Finally, the question of re-location of a roadway to shorten its length, or avoid sharp turns or steep grades is also an important economic problem. As a rule this can only be accomplished in newly developed districts, on account of the heavy expense entailed. There are cases where straight roads passing over hilly districts have been re-located clear around the hills without little or any additional length, owing to the fact that the length of the vertical curve passing over the hills was just about the same as the length of the horizontal curve of the newly located road.

Motor traffic is bound to make use of good roads, and one of the important benefits derived by the community at large, is the wealth distributed by the motor car tourists. We are not getting our share of this traffic in this province, but we can easily see that since our local government has started to improve our roads in an extensive way, light auto traffic has been rapidly increasing every year; the increase is between twenty-five and fifty per cent. for one year over the preceding one. It is figured that each tourist will spend at least ten dollars a day. It is easy, therefore, to figure the advantage derived from this traffic. It is estimated that before the war, France derived $25,000,000 yearly from automobile tourists.

Social Benefits

In conclusion, allow me to enumerate a few of the social advantages derived from good roads. In the first place, they will tend to retain the young people on the farm, which means a great deal from more than one point of view. They will facilitate social and religious intercourse throughout the rural district. They will permit universal free mail delivery. They will fill up the schools, in good weather as well as bad weather. They will improve the aesthetic taste of the farmer; and this point is unquestionably true, as it has been well observed that, as soon as good roads have been in existence through any district, the bordering properties have been beautified by their occupants from year to year, and people in a general way have become happier and more content.

Can all these fine things take place without producing a corresponding amount of happiness and prosperity on the urban municipality? I do not believe so.

The Study of a City's Sinking Fund

By Thomas Bradshaw

Prior to the declaration of war in August, 1914, practically all of our municipal securities were absorbed in Great Britain or at home. Since that epoch-making event, and as a result of it, a new and most important market has been developed. The United States, which had previously been "nibbling" at some of our offerings, has become deeply interested, and has made substantial purchases. We might almost say that New York, for the time being, has assumed the relationship which London occupied.

When normal conditions once more prevail, London will, no doubt, be open again to us, and if so, instead of having, as formerly, only two sources to supply our capital needs, we shall be in the favored position of having three.

The increasing interest exhibited by our neighbors is illustrated by considering the value of the municipal debentures purchased by them in each of the last five years: in 1911, out of total offerings of some $47,000,000, they took $2,335,000, or 4.95 per cent. of the whole; in 1912, $3,900,000, or 8 per cent.; in 1913, $22,100,000, or 19.12 per cent.; in 1914, $25,600,000, or 30.29 per cent.; and in 1915 no less than $32,500,000, or 48.80 per cent. of the whole.

The statement in Table I, compiled from Mr. E. R. Wood's reports, sets forth the proportion of securities absorbed in the three markets:

Canadian investors, who are best acquainted with the constitution and government of their municipal institutions, evidence their faith in them by increasing from year to year the amount of their investments. Last year such investment was over 34 millions of dollars, exceeded one-half of the whole, and was greater than the amount absorbed by Great Britain in the years 1911, 1912 or 1914.

Our friends across the border have the reputation of thoroughly investigating a proposition before making a commitment. Their cautious and gradual investment in Canadian securities illustrates this. During the past four or five years they have been watching and studying our growth. They have been examining into our civic administrations. The history and records of our municipal debts, as well as the manner in which we have met our obligations, are known to them. Frequent visits to our cities and journeying through our provinces have been made by experienced bond men. Numerous inquiries about and investigations of our municipal laws, have been instituted. It is not too much to say, that the United States investor has been favorably impressed with the vast resources of our country, its growing industries, the stability of our institutions, and the general excellence of our government, and it is believed that, as this knowledge grows, the market for our securities will continue to widen.

Up to the present, the American market has chiefly bought the bonds of our more important communities. In trying us out they have, naturally, selected our choicest offerings, and it is believed that their experience has been satisfactory and that, in practically every instance, no disappointments have followed. Shortly it may be expected that consideration will be given to county securities and those of smaller established cities.

In this connection it is most desirable that we should be impressed with the value of this new market; and cultivate it assiduously. We should study its requirements in such a way as to encourage it to take still further interest in our problems and produce. The method in which securities are issued should conform to its requirements, for example: interest on bonds should be made payable in some important American city, as well as in Canada; the repayment of principal in large issues and for long terms, should be according to the instalment principle. The time of marketing and the frequency of our appeals should receive consideration. It is poor policy to force bonds upon a dull and disinterested market, and to make frequent calls for capital. Promptness in meeting our obligations, interest and principal, is vital. Our past record, in this connection, with few exceptions, is all that could be desired.

But above all, the American investor must be satisfied with the financial administration of our affairs. He will be particularly interested in the management of our sinking funds. Perhaps no feature of civic finance in the United States has had occasion to receive more attention and criticism than the conduct of sinking funds. Unfortunately, many instances can be quoted across the border of inefficiency and mal-administration in this branch of municipal administration. Too often the fund has been left in the hands of incompetents, resulting in serious losses. In other instances, the true function of the fund has not been recognized and, in consequence, its monies have been utilized for purposes entirely foreign to those for which they were accumulated. When the debts which the fund was assumed to liquidate, fell due, large deficits were discovered and a process of refunding had to be resorted to.

This brings me to my main theme:

In the early part of this year I was asked by His Worship, Mayor Porter, and the Board of Control of the city of Ottawa, to make an investigation of the city's sinking fund. Although extremely busy at the time, the opportunity was welcomed, because I had been deeply interested for some years in the administration of civic sinking funds and believed that an investigation of the city of Ottawa's fund might be

Record of Canadian Municipals Marketed in the Years 1911-1915

Year	Sold in Canada		Sold in United States		Sold in Great Britain		Total Sales
	Amount	Per cent.	Amount	Per cent	Amount	Per cent	
1911	$16,326,378	34 62	$ 2,334,467	4.95	$28,498,443	60 43	$47,159,288
1912	13,761,482	28 42	3,876,406	8	30,777,074	63 58	48,414,962
1913	25,850,653	22 33	22,135,762	19 12	67,775,510	58 55	115,761,925
1914	25,105,320	29 82	25,559,548	30 29	33,723,563	39 89	84,388,431
1915	34,052,677	51.20	32,455,396	48.80	.....	...	66,508,073

helpful, not only to that municipality, but to others; and for the reason that, Ottawa being the capital of the Dominion, and a thoroughly representative Canadian city, the findings would be of value to our American friends whose growing interest in our securities has been referred to. Mayor Porter was good enough to consent to the publication of my report, and when your Association asked me to contribute a paper on some phase of municipal finance, I thought I might venture to submit it.

I do not propose to read the report, but simply to refer to some features contained in it:—

Ottawa, at the time of the examination, had a bonded debt of $14,417,577—of this amount, $13,094,362 was represented by sinking fund bonds, and $1,323,315 by annuity instalment bonds. The investigation dealt with the sinking fund which was being accumulated to meet the $13,094,362 of sinking fund debt. The debt had been incurred during the last thirty years; it represented two hundred and forty-two different loans which fall due from year to year during the next thirty-seven years.

The result of the investigation disclosed that the city should have in its sinking fund $3,003,147. It was most gratifying to find that it not only had this amount but, in addition, a surplus of no less than $317,369, or 10 per cent. more than the sum required.

The following comparisons of the results of the investigation, with the city's own record, indicate that its affairs had been conservatively exhibited; while the liabilities of the fund, according to the investigation, amounted to $3,003,147, the city had computed them at $3,164,355, or $161,207 more than they actually were; the assets of the fund were found to be $3,320,516, whereas the city had only taken credit for $3,279,405, or $41,110 less than they actually were; the surplus over all liabilities, according to the investigation, was $317,368, the city having only taken credit for $115,050, or $202,318 less than actually existed.

It is advantageous for any enterprise or institution, which has been carrying on its operations under the same management for many years, to have someone from the outside come in and review its work. A strong tendency exists to continue to do things in the same way, because they have always been done in that way. The outside investigator is almost sure to discover reasons why a continuance of customs which might have been satisfactory years ago, is no longer desirable. It is not intended, however, to discuss here methods which, it is believed, might be improved upon, for they are fully dealt with in the report.

The average rate of interest earned by the fund was 3.74 per cent. It, of course, should be the aim of those administering the fund, to so invest the monies that, consistent with absolute safety, the highest rate shall be earned. A difference of only one per cent. would bring the average rate up to 4¾ per cent., and would mean that the fund would have annual additional earnings of $30,000.

We hear much about the difficulty of operating such public works as electric light and waterworks systems, street railways, etc., so that they will produce a surplus revenue over expenditure and debt charges, but seldom, or never, is there presented to us the possibility of a sinking fund being so administered that it will produce a surplus and thus contribute materially to the city's revenue.

A word might be said as to the character of the investments in the Ottawa sinking fund: Of the $3,300,000 in the fund, $1,855,000 consisted of that city's own bonds; Dominion and Provincial Government securities accounted for $300,000, and the balance of $1,165,000 was made up of cash, etc. It will be noticed that 56 per cent. of the holdings comprised the bonds of the city itself, and in the report the question is raised as to the desirability of making further such investments.

The outstanding and important features, however, of the whole investigation are: that for all outstanding debenture debts, the city had on hand good interest-bearing investments or cash, of an amount substantially in excess of the full sinking fund requirements; and that the fund had been honestly administered.

It is believed that the facts disclosed in the report will tend to enhance the favorable opinion already entertained in the United States, of the administration of our important municipal bodies, and add to the good reputation of their credit and securities.

Cost of Concrete Pavements

The town of Welland, Ont., D. T. Black, Town Engineer, have just awarded a contract for the construction of 7,000 square yards of pavement on Burgar Street. This has been awarded to the lowest tenderer, McRae & Campaigne, at $14,168.18. The road will be of 4-inch tarvia on 5-inch concrete base. It is interesting to note that the relative tenders submitted on the various kinds of roadway were fairly close. We are able to reproduce the figures herewith in Table 1. It will be noted that the four tenders similar to that accepted, namely, tarvia on concrete base, ranged between a maximum of $17,762 and a minimum of $14,168. Three tenders were submitted for reinforced concrete roadway, the highest being $17,896 and the lowest $17,121. The single tender submitted for a 4-inch brick roadway on concrete base was very much higher than the others, namely, $26,863. It is also interesting to note the varying estimates placed by the different contractors on the work under the different headings:

Table I
Prices for 7,000 Square Yards of Pavement for Burgar Street, Welland, Ont., August, 1916

Tender No.	Kind of pavement	Price per square yd.	Extra excavations cub. yd.	Extra haul per 100 ft. per cub. yd.	Fills per cub. yd.	Straight curb and gutter combined per lin. ft.	Straight curb per lin. ft.	Curved curb and gutter per lin. ft.	Curved curb per lin. ft.	Concrete headers per lin. ft.	Total amount of tender
(1)	4" tarvia on 5" concrete base ...	$1.88	.80c	.10c	.80c	.58c	..	.60c	..	.25c	$16,069.64
(2)	Reinforced concrete	$1.93	.80c	.10c	.80c	..	.58c	..	.60c	.25c	$17,565.93
(3)	Reinforced concrete	$1.85	.80c	.25c	$1.50	..	.75c	..	.75c	.50c	$17,896.10
(4)	4" tarvia on 5" concrete base ...	$2.00	.80c	.25c	$1.50	.75c	..	.75c	..	.50c	$17,762.75
(5)	4" brick on 5" concrete base	$3.15	.80c	.25c	$1.50	..	.75c	..	.75c	.50c	$26,863.50
(6)	Reinforced concrete	$1.89	.80c	.03c	.80c	..	.55c	..	.65c	.32c	$17,121.08
(7)	4" tarvia on 5" concrete base....	$1.80	.80c	.03c	.80c	.79c	..	.89c	..	.32c	$16,554.19
(8)	4" tarvia on 5" concrete base ...	$1.63	.50c	.01½c	.80c	.60c	..	.65c	..	.17c	$14,168.18
(9)	2" bitulithic on 5" concrete base.	$2.40	.70c	.01c	.75c	.55c	..	.60c	..	.50c	$19,333.95
(10)	2" Warrenite on 5" concrete base	$2.00	.70c	.01c	.75c	.55c	..	.60c	..	.50c	$16,704.75

Catskill Aqueduct Concrete Forms

THE new Catskill aqueduct for the water supply of New York city is one of the most remarkable engineering feats of the present age. Its construction involved many unique and novel developments and its size gave large scope for the exercise of much ingenuity and skill in building operations. The various contractors developed different methods of executing the work, and a comparison of their results is interesting. One special problem that required careful planning was the design of the form work which involved material changes to obviate objectional features that experience and experiment made apparent. In the following article, reprinted from "Contracting," are described some of the forms used on that part of the aqueduct which is horseshoe-shape in cross-section, a portion about 55 miles in extent:

Conditions and Requirements.

As an economical location of the line was such as to involve only enough excavation to provide sufficient cover for the finished aqueduct, much of the structure was built in an open trench about 50 ft. wide on top and 12 ft. deep, with sloping sides. This provided convenient access to the work, and permitted, when necessary, the installation of equipment alongside to handle the forms and materials.

The principal requisites for the inside forms were that they should be generally suited for repeated use; that they should secure exactness, uniformity, and good finish of the concrete structure; that they should have sufficient strength and rigidity; that they should be easily shifted, put in position, and adjusted; that they should be of convenient dimensions, moderate weight, and simple construction, and that they should provide for very accurate alignment and centering, so as to make consecutive sections of the concrete uniform, without irregular shoulders at the joint.

Various types, dimensions, and details were used in the work by different contractors, and as the work was of unusual dimensions, many of the forms first tried required material changes, until finally most of the objectionable qualities had been eliminated and several varieties of forms had been developed that proved satisfactory. Those that endured the test and were adopted for the latter part of the work form the principal subjects of this article, since space does not permit study of the different steps in the development, and it suffices to show the final results, with brief references to earlier forms and their faults.

Forms and Curves.

The aqueduct design contemplated the use of straight forms for tangents and for curves with radii of not less than 700 ft., all sharper curves being made with a uniform radius of 200 ft. It was found, however, that fillers, or some other special devices, were required to supplement the regular forms, even on flat curves, and an effort was made to eliminate special forms for curves.

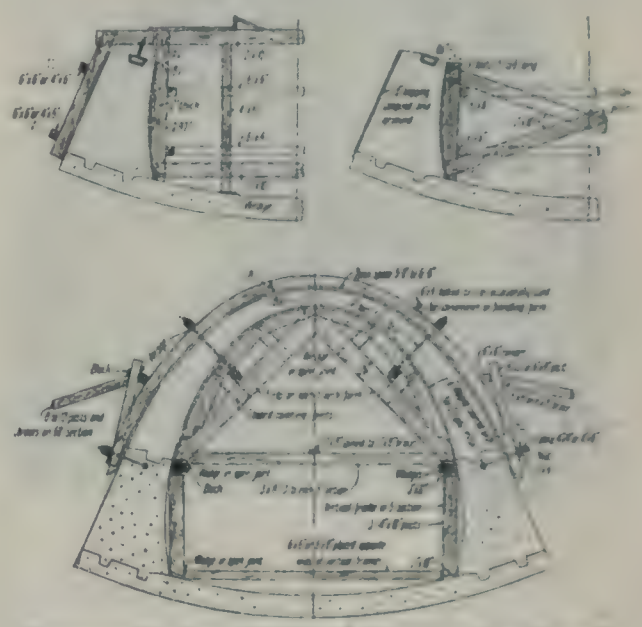
This was accomplished, in one case, by making all forms beveled at the ends so that by matching long and short sides alternately a tangent line would be made and by placing all the long sides of the forms contiguous the convex side of a curve would be secured. A 200-ft. radius was thus provided for by making the forms uniformly 5 ft. long.

Throughout the aqueduct nearly all of the construction was concreted in two steps, namely, that of the invert and of the remainder of the cross section, including the side walls and arch. Separate construction for the side walls was difficult, and was adopted only on a portion of the aqueduct in the Wallkill Valley.

Very low side walls, amounting merely to extensions of the invert a few inches high, were built in one instance in order to dispense with a wooden sill for supporting the arch form. It proved to be difficult to provide a satisfactory surface on top of these low walls, and they were, therefore, abandoned.

Interior Wooden Forms.

Wood was used to a much greater extent for the construction of the outside forms than for the inside forms. Wooden forms for both inside and outside of the aqueduct were used on a small portion of the work. Here, as in all other parts of the cut and cover aqueduct, the invert concrete was first laid in alternate



Interior and exterior wooden forms for separate arch and side wall construction.

strips 16 ft. long, with straight longitudinal planks for the side forms. The end forms were usually steel plates, although planks were sometimes used for them.

No upper form was required, the concave surface being produced by the longitudinal movement of a transverse screed bearing on the platforms and having a convex steel edge or by a longitudinal straightedge screed moved transversely and bearing on the end bulkheads cut to the invert curve. Another method of forming the invert surface was by rolling it with a longitudinal piece of steel shafting or concrete-filled 4-in. pipe that engaged concave transverse guides or bulkheads at ends of the 15-ft. section.

The headworks section of the aqueduct was built with wooden inside and outside forms, here illustrated. They were made in four longitudinal sections for the interior and substantially in one section for the exterior. Here the side walls were concreted separately, with tongue and groove connections in the arch and invert joints.

The interior side wall forms had horizontal longi-

tudinal lagging attached to scarf boards on a vertical timber framework. They were seated on the invert concrete and were adjusted and braced by horizontal transverse struts and by longitudinal and transverse diagonal braces. The outside wall forms were simple panels of lagging nailed to transverse cleats, and the tops were secured to the projecting ends of the upper horizontal transverse struts for the interior forms. They were also braced by outside struts, indicated by dotted lines in the illustration.

After the side walls were concreted and the forms removed longitudinal vertical bents were set on both sides of the invert, close to and about as high as the side walls and capped with longitudinal planks on which the interior arch forms were seated and adjusted. The latter were made in two longitudinal sections, with a crown joint adjusted by wedging. They consisted of pairs of framed transverse ribs or semi-arch trusses, with curved top chords, to which wooden lagging was spiked. They were made in 5-ft. lengths,

Heavy steel form with one-hinge arch truss bracing.

three of them being bolted together for convenience, except on curves, where fillers were inserted between them on the outside of the curve.

Exterior Wooden Forms.

The exterior forms were made in 15-ft. lengths, with transverse exterior ribs 4 ft. apart on centres. Each rib was made of two 3 x 8-in. pieces, breaking joints, and thoroughly bolted together. The concave undersurface was covered with 2-in. tongue and groove lagging up to a point about 3 ft. from the crown, where a full length opening 6 ft. wide was left for the introduction of the concrete. The outer and inner forms were fastened together by bolts passing through the concrete at the haunches, and the lower edges of the outer forms were secured by bolts previously built into the side wall concrete.

The interior forms were collapsed by horizontal turn-buckle rods engaging the lower end of the ribs. When moved ahead from section to section, they were given bearing on 2-in. rollers and were pulled forward by a hoisting engine.

The side walls forms were set ½ in. wider apart and the arch forms ¼ in. higher than the theoretical dimensions of the aqueduct. The outside forms were removed after 12 hours, the inner wall forms after 48 hours, and the arch forms after 72 hours. Before the completion of the work the forms began to distort, and it is thought that for long service it would have been more economical to have provided steel forms at a higher first cost.

On another section of the arch the contractor used interior forms 15 ft. long with 2-in. wooden lagging covered with sheet iron and fastened to ribs 4 ft. apart. They were connected by trench braces engaging the vertical wooden ribs and were collapsed by operating the braces. The arch forms had ribs 4 ft. apart, carrying 3-in. wooden lagging braced by radial wooden struts, and were supported on a traveler. They were adjusted and collapsed by horizontal turn-buckle members connecting the ribs.

Outside forms were made with steel T-ribs and shiplap wooden lagging. They required a great deal of bracing besides that provided in the original design, and, although they gave satisfactory concrete results, they required a great deal of time to handle, and on that account were superseded by steel forms.

Interior Steel Forms.

About 11,200 ft. of aqueduct was built by King, Rice & Ganey, using very heavy interior steel forms made with two longitudinal sections in 5-ft. lengths and provided with wooden fillers at points of curvature. The two halves of each form were hinged at the crown, and were made with very heavy trusses spaced 5 ft. apart and covered with ¼-in. steel plate stiffened by longitudinal purlins.

They rested on long longitudinal wooden sills wedged up from the invert. They were braced and adjusted by horizontal steel pipe struts with jacks at one end; they were collapsed enough to move through the completed parts by removing the wedges and sills, separating the steel plate from the concrete by steel wedges and lowering the forms on the carriage by means of jack screws. They were moved forward in 15-ft. lengths.

The forms were easily and quickly set up, collapsed, and moved; they were rigid and produced a smooth, clean surface, and although heavier and more costly than some of the others, were said to be the most efficient cut and cover forms from both the contractors' and engineers' viewpoints. One hundred and ninety-five lineal feet of forms were provided, and they were generally used for concreting 60-ft. lengths of aqueduct.

A large amount of the interior steel forms used were of the Blaw and Ransome types, besides which McNally and Owego types were also used. Some of these forms have been well developed, became practically standard on the latter part of the aqueduct work, and are so well known that detailed description here is unnecessary.

Reinforced Concrete Street Signs

Still another new application of reinforced concrete is represented by signs for the names of streets. These are made of white Portland cement and crushed granite, suitably reinforced, the letters being moulded in a plastic state and dovetailed into the groundwork, making the whole a monolithic structure. The letters are colored so as to contrast effectively with the white background.

Damage to the extent of $100,000 was done to the plant of the Winnipeg Paint & Glass Company by fire recently. The woodworking mill, boiler house, and several dry kilns were destroyed. The company has decided to rebuild the factory immediately.

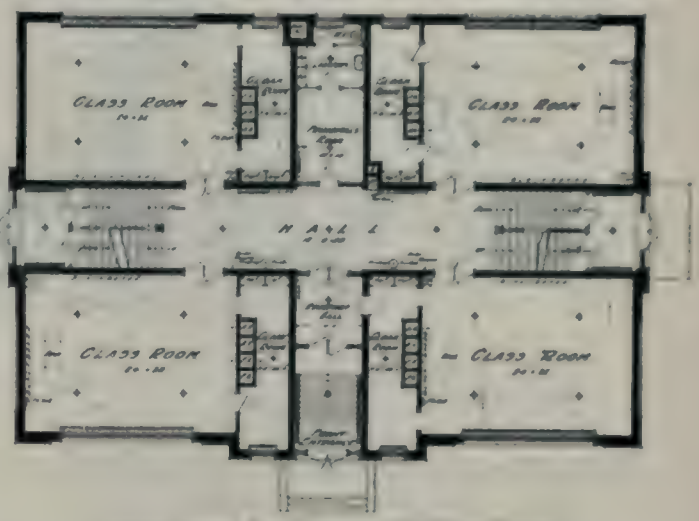
West Ward School, Pembroke

The cuts reproduced herewith illustrate the proposed public school for the West Ward, Pembroke, Ont. It has been carefully planned to serve its purpose, and, although its exterior has been designed without excess ornamentation, it does not in any way detract from its imposing appearance. This particular building is typical of the finer class of educational institutions being erected in many of our towns.

The structure measures 95' x 65', and will be two full storeys in height, containing eight standard class-rooms. The construction throughout will be entirely fireproof, involving reinforced concrete slab floors on columns of the same material. In keeping with this design, the roof and stairs are of fire-resisting material.

Each floor contains four class-rooms, uniformly 24' x 32' in size, with adjoining cloak rooms. The first floor plan shown is typical, the principal's room and reception room being replaced in the upper floor by teachers' rooms. A corridor runs the full length of both floors, with entrances at both ends on the ground floor. The basement contains boiler room, lavatories, and play rooms for both boys and girls. The equipment is very complete, including steam heating, electric lighting, and a ventilating system of modern design. One illustration reproduced herewith shows the arrangement of the ventilating scheme, with the fresh and foul air ducts.

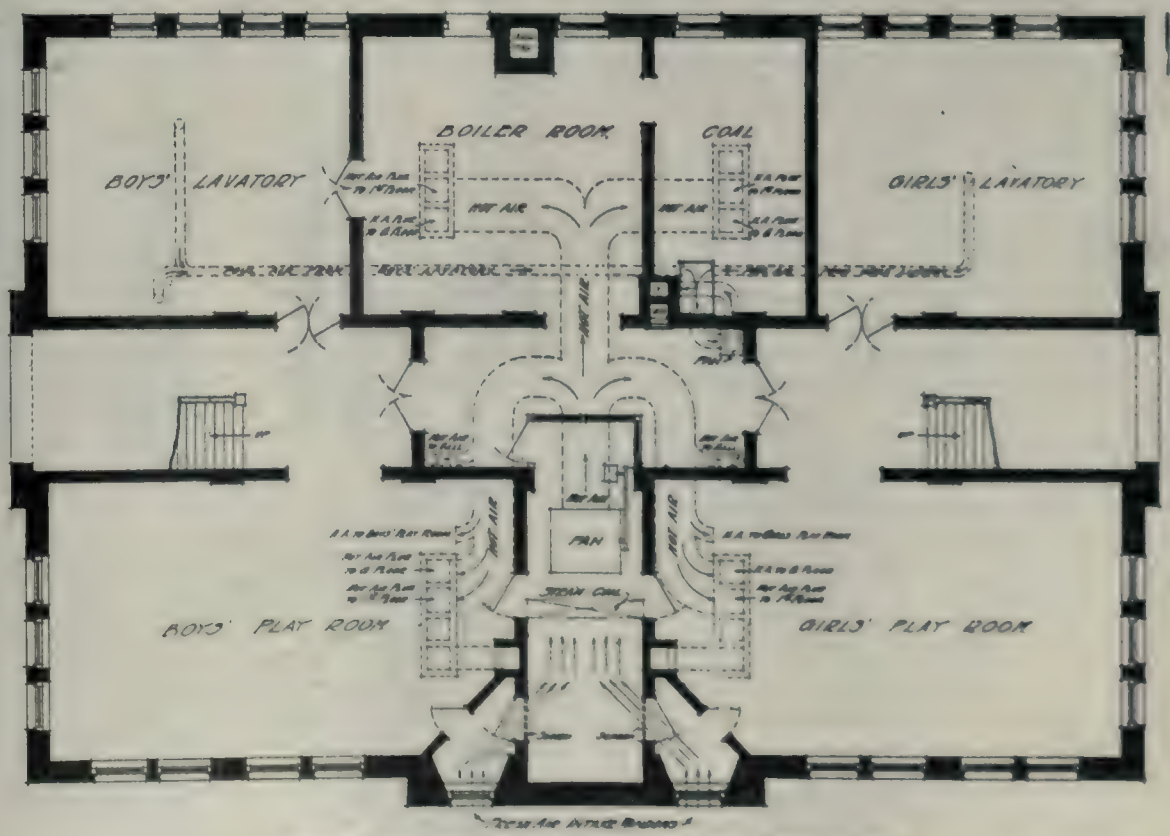
It is proposed to build the foundation walls up to the ground floor level of concrete, with local blue limestone facing above ground level. The remainder of the structure will be faced with brick, while the front entrance will be designed in Indiana limestone. The interior is to be finished in ash and clear white pine, with birch flooring for class-rooms, cloak-rooms, and teachers' rooms. Asphalt flooring will be employed in corridors, halls, play rooms, and lavatories, while the remainder of the basement floor will be of concrete. The stairs are fireproof, of steel and iron construction, with asphalt treads, and the roof is of Johns-Manville



Plan of ground floor, Pembroke West Ward School.

built-up asbestos roofing, pitched to two inside gutters. A metallic ceiling will be employed in the upper storey.

Fire alarms, telephones, and a bell system are installed in each room. A system of ventilation is employed, incorporating Sheldon's ventilating appliances. The building will be lighted with electricity and heated by steam, the boiler being a Taylor-Forbes



Basement plan showing heating and ventilation layout, Pembroke, Ont.

smokeless boiler. The plumbing equipment is especially complete, with sanitary drinking fountains throughout. A noteworthy point is that the seating arrangements are such as to allow left-hand lighting from the ample window space.

The building has been designed by Mr. W. C. Keighley, architect, Pembroke, and Mr. H. P. Beck,

Architect's perspective, Pembroke West Ward School.

of Ottawa, is the contractor. The cost will be approximately $53,000.

Strength of Clamped Splices in Concrete Reinforcement Bars

The following paragraphs, taken from the proceedings of the American Society for Testing Materials, give results for a number of experiments intended to investigate the strength of clamped splices in concrete reinforcement bars:

Concrete reinforcement bars are received in lengths varying up to about 60 feet. The length most commonly selected, however, is in the neighborhood of 30 feet; hence it is frequently necessary in practice to lap one bar over another. It is also desirable upon more or less frequent occasions to secure a splice capable of withstanding a greater tensile stress than that which a plain lap splice can resist. In such cases, U-bolt clamps, such as are ordinarily used in fastening wire cables together, have been successfully employed, one at each end of the overlapping bars. The meagreness of available data on the strength of such splices prompted the tests, the results of which are here recorded.

U-bolt clamped splices of both 17 and 21-inch lengths of splice were tested to determine the load at first slip, and the maximum load the splice would resist. Three different classes of splices were thus tested —lap splices not embedded in concrete, butt splices not embedded in concrete, lap splices embedded in concrete. The reinforcement steel in all cases consisted of 1-inch square cold-twisted bars.

The loads necessary to produce first slip had a range from 7,000 to 50,000 pounds. The maximum load which the splices withstood varied from 23,000 to 69,000 pounds. The ratios of load at first slip to yield point of bar for clamped splices not embedded in concrete varied from 12 to 21 per cent., and for splices embedded in concrete from 53 to 83 per cent. Ratios of maximum load to tensile strength of bar ranged from 31 to 61 per cent. for embedded splices, and from 79 to 95 per cent. for embedded splices.

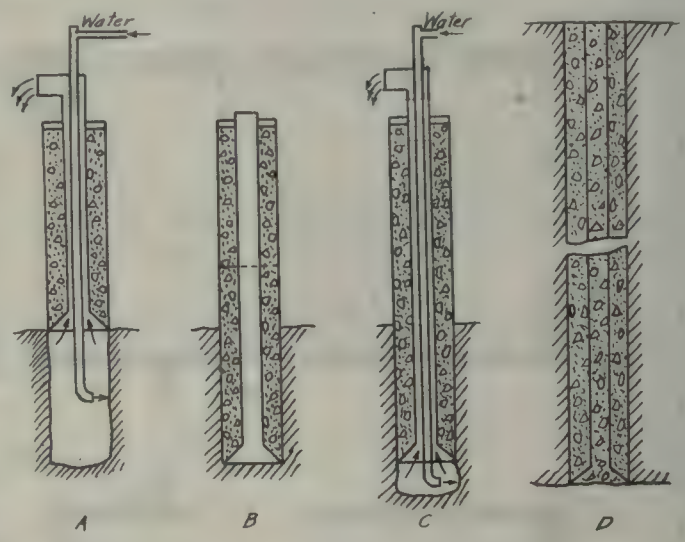
It was found (1) that lap splices are stronger than butt splices; (2) that splices in which the two overlapping bars are of opposite twist apparently are stronger than splices in which the bars are of like twist; (3) that the lengths of lap, as to the two lengths tested, did not affect the strength of the splice; (4) that embedding the splices in concrete increases their strength materially; (5) that clamped lap splices embedded in large masses of concrete undoubtedly can safely withstand a unit load equal to the unit stress of the steel reinforcement.

Replacing a Defective Foundation With Concrete Piles

The following describes a method employed in checking the settlement and making stable the foundations of a building founded on soft ground overlying a deep cemented gravel stratum. Concrete piles were sunk in pairs on each side of the old foundation walls to a bearing on the cemented gravel, and on these were carried reinforced concrete beams, which supported the walls of the building. After the foundation was completed, the original one was removed and a firm base on a solid bottom was provided for the structure.

The pile employed is illustrated herewith. It consists of an outer steel casing, at the bottom of which is an entering piece or "point." An inner tube is also fastened to this point by an inverted conical funnel. In this way a sharp cutting edge is provided. The space between the two tubes is filled with concrete, and sinking is carried on by jetting through the inner shell.

The method of procedure is to set a section of the shell in position, with a guide frame around it to keep it straight during its descent, the space between the inner and outer tubes being filled with concrete. A pipe is inserted in the central space and connected to a water supply under pressure. A nozzle at the end throws a jet horizontally with considerable force. This jetting apparatus is capable of being freely moved vertically or rotated. By manipulation of this jet a



hole is bored below the cutting edge of the pile, debris and water passing through the centre. When the first section of the pile reaches its level, a second is attached. Concrete is placed and sinking resumed by the same method. Extension and sinking is repeated until the required depth is reached. The space beneath is then washed out and filled with concrete, including the central shell. In the particular building in which this method was employed, 153 piles, from 22½ inches to 30½ inches in diameter and from 108 feet to 112 feet long, were sunk.

The illustrations above show the various stages and details of the process, and are self-explanatory.

Foundations for Road and Street Pavements

By Joseph W. Hunter*

The object of a pavement is to secure as nearly as possible a uniformly hard, even, and durable surface upon which the traffic must pass. Upon the foundation of a road depends its strength, mainly to resist the impact force or blows of heavy traffic. Not to any considerable extent, nor necessarily, should the pavement support the weight of heavy loads, and unless the pavement is supported by or rests on a firm and solid foundation it will soon become rutted and full of depressions. To insure the stability of a pavement it is necessary to have as firm and as good a foundation as for any other structure. A foundation once put in cannot be changed easily.

Bad foundations ruin any structure and invariably cause bad pavements. With a good foundation, the wearing surface depends on the quality of the material used for paving and on the manner in which it is laid. As a general rule, the subgrade or subfoundation does not receive the attention it should in construction; it cannot be too carefully prepared. It should be thoroughly drained and compacted, soft material removed, and fills of any considerable depth, say, three feet or over, should be allowed to settle for a period of from six to twelve months, before the foundation, which is to carry the wearing surface, is placed thereon. It is the subgrade that virtually carries the load and resists the blows of heavy traffic. The camber or slope of the subgrade should be the same as that of the finished pavement wherever practical This part of preparing the subgrade should be given particular attention where a pavement is to be laid on a fill or on a surface that may have been disturbed even three months and in some cases a longer time prior to the laying of the pavement.

It is proposed to divide the subject under discussion, "Foundations for Road and Street Pavements," into two classes—Natural and Artificial.

A Natural Foundation.

A natural foundation is one where paving material is laid directly upon the subgrade. Hard shale, gravel, or a sandy loam when properly prepared makes a foundation upon which can be laid to advantage bricks, stone block, macadam, or concrete. In cases where the natural foundation can be used to advantage for a brick or stone block pavement a sand filler should be used. The writer believes that a wire cut brick, laid in such a manner, will make a good and lasting pavement at a minimum cost for construction and upkeep.

Before concrete is laid as a pavement on a natural shale or earth surface, there should be spread a layer of cinders or crushed stone at least six inches in depth, as a cushion and to keep the moisture away from the base of the pavement. Where concrete is laid directly on the earth the moisture therefrom drawn into the concrete by capillary attraction will in a comparatively short time cause a disintegration or breaking up of the pavement. The cinder or crushed stone may not be necessary when the concrete is used as a foundation upon which to place a wearing surface of other material, but it would be good practice under most conditions to use either for drainage purposes. The construction would be better, and in a great measure lessen the number of cracks in the concrete surface. Concrete as a pavement laid upon a telford foundation where the macadam was washed off showed no cracks after being down for more than eight years.

A natural foundation of gravel, containing sufficient loam to bind it, is one upon which a pavement of bricks, stone blocks, and macadam can be laid to advantage. A sand filler should be used. The gravel upon which concrete is to be placed should be practically free of loam or clay. When a sandy soil is used as a natural foundation, it should be bonded with just enough clay to hold it in place until the pavement is laid. A water-bound macadam pavement laid upon a gravel foundation containing a sufficient amount of clay or loam to allow of its becoming thoroughly compacted will last longer than if laid on any other foundation. The macadam surface very rarely distintegrates. This is particularly so when the pavement is of good, hard limestone. Hard shale, when properly shaped and thoroughly drained, forms an excellent foundation for a macadam pavement, and if covered with a 1½-in. sand cushion makes a first-class foundation for a brick or stone block pavement. A sand filler can be used. The writer knows of a wire-cut brick pavement laid on a clay subgrade, with cinder as a cushion and sand for a filler, that has been in use for more than twenty-five years. This pavement has been subjected to exceedingly heavy traffic and is still in good condition.

An Artificial Foundation.

Among the artificial foundations suitable upon which to lay a pavement to meet the requirements of traffic are concrete, rubble concrete, being rubble stones set on edge, but not in contact and the spaces between filled with concrete; a telford base laid with either rubble or cobble stones, with the interstices well and tightly filled and broken stones laid as in a macadam road. The character of foundation to use will depend on the volume of traffic and to a greater or less extent on the type of surface to be placed thereon.

Concrete has become an approved foundation for a brick, stone block, asphaltic block, wood block or an asphaltic concrete pavement. The necessity of using a cushion on the concrete base is one about which opinions differ.

The writer is of the opinion that when a sand cushion is used much, if not all, of the rumbling in brick pavement can be eliminated by the use of a sand filler instead of a cement grout. Sand as a cushion will, as the bricks are being laid, work up between them. The water in the grout will moisten the sand and for a time hold it in place, but during hot weather the sand will become dry and settle or shrink, thus leaving a void that is never filled, which separately or in conjunction with the buckling of the monolithic surface gives an opportunity for the rumbling noise so often heard when traffic passes over the pavement. If a cement grout is to be used, the brick should be set in a bed of cement mortar from ½ to ¾ in. thick, so that the whole structure will be monolithic. The mortar should be composed of slow setting Portland cement and clean, sharp sand in the proportions of one part of cement to four parts of sand, mixed to the consistency of damp sand, but not slushy; and care must be taken to spread the mortar evenly with a templet. Upon such a bed of cement mortar can be set asphaltic block, stone block, and wood block for a pavement. However, the life of a wooden pavement will be longer if a

*First Deputy Commissioner, Pennsylvania State Highway Department, before American Road Builders' Association.

sand cushion is used to absorb a portion of the shock of the traffic which passes over it.

Another method of laying a brick or stone block pavement upon a concrete foundation is to cover the concrete with from ¼ to ⅜ in. of tar and set the brick or stone blocks therein, using cement grout as a filler. The tar will work up between the joints of the bricks and meet the cement grout and thus prevent the rumbling which is characteristic of a brick pavement. A ¼-in. tar surfacing should be placed on a concrete foundation before placing thereon an asphaltic concrete pavement.

One of the principal causes of the disintegration and partial failure of bituminous macadam and asphaltic cement pavements that have been laid on an old macadam foundation without careful preparation or reconstruction is due to the lack of sufficient drainage in the subgrade. The moisture generated in the subgrade passes through the macadam and evaporates at the surface. The bituminous material of any kind acts as a waterproof covering and prevents the evaporation and causes a concentration of the moisture, and eventually a soft spot in the road appears and a breaking up of the pavement begins. The moisture, in addition to concentrating in the base of a subgrade by reason of capillary attraction, attacks the asphaltic or bituminous pavement from beneath and sooner or later ruins it. The more free carbon in bitumen the greater the absorption. As a matter of safety an old macadam construction to be used as a foundation for a bituminous pavement of any kind should be brought to a true surface by using crushed stone, and then be covered with two or three inches of concrete before the bituminous mix is placed thereon. This will undoubtedly preserve the life of the pavement.

A telford foundation which has been used in the original construction of a telford water-bound macadam road, from which the macadam has been worn or otherwise removed, makes an ideal foundation when brought to a true surface by the use of concrete upon which to lay a bituminous pavement; the drainage being nearly perfect, provided that the stones were originally set on a properly prepared subgrade. This construction prevents any concentration of moisture and a first-class foundation upon which to lay a brick, stone block, or asphaltic block pavement. Telford construction makes a good foundation for a concrete pavement.

When roads are reconstructed with a view of utilizing in the future such reconstruction as a foundation for some form of pavement the writer strongly urges the telford method of construction as being the most practical and as having a greater future use.

It is recommended in cases where the macadam has worn and conditions do not warrant the construction of any other form of pavement that a telford base be substituted for the macadam, with a view of being able to use it in the future as a foundation upon which to lay another form of pavement.

In conclusion, the principal essentials to be considered in determining the construction of a foundation for a pavement are first drainage and the careful preparation of the sub-base or sub-foundation. The life and usefulness of the whole structure depends on this essential. Then the kind and amount of traffic must be carefully considered and the character of the surfacing to be placed on the foundation must be determined. Without careful attention to the essentials a foundation will fail, and consequently the pavement will be ruined.

Hollow Tile in Building Construction

To trace the origin of hollow tile construction it is necessary to go back only so far as the early "skyscrapers," the first of the iron and steel framed office buildings, and the necessity for a fireproofing shell around the metal framework of these early buildings. These were of themselves a revolutionary type of construction, conceived and developed within the memory of men now not past their prime. The hollow, clay tile was developed as a lightweight insulation and fire protection for the iron frame of these pioneers among the tall office buildings—a by-product of the modern office building, so to speak.

The completely constructive building materials may be counted on the fingers of a hand—wood, stone, brick, concrete, hollow tile. The evolution of a new building material is an epoch-making thing. The use of wood, stone, and brick go back through all the annals of civilization, past its earliest records. The ancient civilization which did not have stone available for building purposes, made brick and built with it. Brick was the building material of the ancient Assyrians. While we have seen a wonderful development in the use of concrete, it is really a very ancient material, known and used in very early times. Terra cotta is generally used as a facing material, and does not properly come in this list.

Hollow tile. alone, of these materials, has been developed during the last few decades, and several reasons account for its popularity. The obvious economy of using a hollow tile a foot square, or thereabout, in place of perhaps fifteen or more smaller units, lies not only in the shorter time in which it may be laid in the wall, but also the saving in handling the larger unit. Any saving in the actual amount of clay used is important only as it results in an accompanying—and equally desirable—lack of weight. Moreover, from this economy of material and lack of weight has developed the basic principle and greatest positive advantage of hollow tile as a building material—the dead air spaces which make an insulation in the wall against both heat and cold, fire or storm.

A seeming coincidence lies in the fact that just as hollow tile was being applied to building purposes in this way the building public began to realize the essential importance and desirability of a comparatively inexpensive and at the same time commercially practicable type of fire-resisting construction.

In its early manufacture hollow tile was made in very simple designs and with few patterns. But as the tile has come to be more and more used in dwelling construction there has been a growing tendency to improve its design by details giving a more thorough insulation and better bond in the wall; to provide designs for special places, such as door and window openings. jamb and sill, floor joists, corners, etc., to lessen the labor and trouble on the work, to improve the technical means of its employment, and to reduce the cost to the owner.

The several standard makes of hollow tile have been accepted by building departments as desirable

building materials, and many local factories manufacture a good product. Each type has its own peculiar advantages in design and manner of laying, and each has its own special forms designed for special positions. It is extremely interesting to follow the peculiar adaptations which have been worked out to fill special conditions, as, for instance, for the jamb and sill for window openings; methods of reinforcement for lintels and wide openings; to give a good bearing for floor beams; to form corners; to set partitions; to break a continuous joint through the wall; methods of breaking joints and bonding the tile in the wall.

Of special interest may be mentioned the very practical types of fire-resisting floor construction. The time will come—and it is not far distant—when it will be considered necessary to put an effectual fire stop between the basement, with its possibilities of overheated furnace, badly constructed hearth or flue, and the living quarters of the family, though there is no indication that the time will ever come when we shall consider anything else so satisfactory and beautiful to live with as a well-finished hardwood floor and woodwork. When a house is built of fire-resisting material people will feel justified in putting more beautiful wood into its finishing.

The possibility of applying stucco and plaster directly to both the exterior and the interior face of the wall simplifies construction and reduces expense, though in many cases furring is applied to the inner surface.

Hollow tile requires essentially a ten or twelve-inch wall as a minimum for residence work, as compared with the six-inch wall of timber construction. With modern compact building every inch of space is expected to bring its return in value, and hollow tile is designed to give not only bearing strength and the protection expected from a wall, but in addition the fire resistance and the insulating qualities of greater value than the space occupied. Estimates vary as to the relative cost of tile and timber construction. Ten per cent. additional cost for a fireproof construction is an estimate often given. In special cases and conditions it may run considerably less and in others it may exceed 10 per cent., depending on the construction, labor, and transportation conditions. We are told the contractor's uncertainty as to the use of tile and its results sometimes accounts for his high estimate. He prefers to build in the more usual way, and figures accordingly, with an allowance to cover suspected trouble.

Among the later developments is a tile with a "tapestry" or finished surface, which does away with the necessity for a brick veneer or coat of stucco. This, if generally adopted, would again have a revolutionary tendency on architectural effects. Scale is one of the most important elements with which the successful architect works his spell. The eye accepts the small unit of brick as an established standard. A unit as much larger as the tile provides will set a different scale and make different requirements.

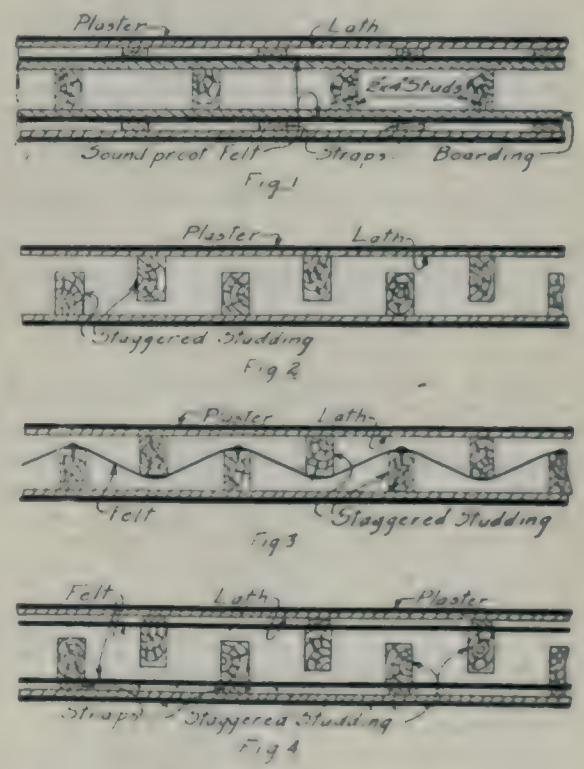
The architectural possibilities of the plain stucco and cement surface have hardly been touched as yet. The very facility with which it is worked, its lack of limitations, has made its early use either commonplace or in imitation of other materials. Spanish colonial stucco work in Mexico was the inspiration for the very interesting buildings in the permanent group erected at San Diego for the exposition which charm visitors, and show some of the various phases of its possibilities as applied to structures both ornate and simple.

Fundamentally the influence exerted by the fireproof and the hollow tile house is manifest in the simpler general lines, and more especially in the grouping of windows. Special construction is required for each opening. When several windows are required in the wall of a room it is manifestly simpler for them to come together in one bank, saving the labor of the several different openings in the masonry where one opening can be made to serve the same purpose. This is resulting in a distinctive character of exterior treatment capable of infinite variation under architectural handling.—Keith's Magazine.

Sound-Proof Partitions

There are many occasions in building construction when walls or partitions possessing reasonably sound-proof qualities are required between adjoining rooms or apartments, in order to deaden the noise that might otherwise be transmitted. Many walls of this nature, involving considerable expense, have been developed for large structures, but for residences or buildings of a similar nature, costly methods are prohibitive, although in many cases it is quite as important to devise effective methods of sound prevention.

In the following paragraphs a few of the commonly



used means of deadening partitions are described, in conjunction with the accompanying illustrations. The methods so outlined will impress the builder as being fairly effective for their purpose and at the same time quite inexpensive, involving in many cases merely a slight readjustment of the ordinarily accepted stud and plaster partition.

The object to be attained in maintaining sound-proof properties for a partition is to prevent the transmission of vibration from one side to the other through the medium of the wall material. Rigid partitions, with the two sides firmly nailed together, as in the ordinary stud and plaster wall, transmit sound very easily, since sound vibrations acting on one side are not greatly intercepted or reduced while passing through the wall. By using a sound-absorbing material, such as felt paper, the volume of sound passing

through can be very materially reduced. By constructing a partition in such a manner that the two sides do not form a rigid unit, even greater advantages in this regard may be obtained.

A stud and plaster partition can be deadened to a certain extent by filling the space between the laths with fibre, mineral wool, or felt. Sound-proof felt may be placed on the outside of the studs and gives fairly effective sound-deadening properties. Fig. 1 illustrates this type of wall, the felt being nailed to close boarding, which may be omitted if desired. The lathing is fastened to straps on the outside of the felt. The objection to this wall is that the felt only partly deadens the sound as, the two sides being fastened together, the absolute elimination of the passage of noise is not obtained.

The most efficient way to secure a sound-proof partition is to have the two sides separate and distinct, as is done in Fig. 2. This can be secured by staggering the studs, as shown. In this way two walls are obtained, and if they do not touch in any way, very little sound will be transmitted through the space. About twice as many studs are required, since the spacing must be normal on each side. Care must be taken to see that the two sides are sufficiently separated so that the bridging of one set of studs will not touch the other set and in that way link the two together. A wall employing staggered studs will be somewhat thicker.

The deadening will be made nearly, if not absolutely, perfect by nailing heavy felt to one set of studs, as shown in Fig. 3. This very effectually stops the passage of noise. Lath and plaster on the outside complete the wall.

In Fig. 4 is shown a partition of the same general type, in which the felt between the studs is replaced by similar material on the outside, with straps, lath. and plaster over all. Or the ideas in Figs. 3 and 4 may be combined.

The above methods describe the usual types of partitions that may be installed in houses or small buildings when it is desired to prevent the passage of sound. It must be pointed out, however, that an absolutely sound-proof wall is difficult to obtain, but those illustrated are inexpensive types that are fairly effective and are quite applicable to residence designs.

Motor Trucks as Locomotives

New uses for motor trucks are always being discovered. Their employment for hauling purposes possesses many advantages. and they are even replacing locomotives on narrow-gauge railway lines. On several road-building schemes they have been used to carry material and even to pull dump cars. In one particular instance a train of this nature is being used, as the ordinary type of locomotive was found unsatisfactory, inasmuch as the speed developed was too low to make track hauling a success when the high investment was considered. Moreover, the heavy locomotive involved high track maintenance, especially in springtime, when the ground was soft. The contractors use a four-wheel-drive motor truck, three tons capacity, as an engine to pull the cars, instead of a geared locomotive. The truck straddles the rails and soon develops a smooth rut to run in, which may be cheaply maintained. One man can take care of three or four miles of track quite easily, as surfacing for the light cars need not be so carefully done as for the locomotive. Speeds of twenty miles an hour on straight runs are often developed. The great advantage of the motor truck in such a case is that it can uncouple and climb in or out over the rails at any point. This makes switching operations particularly easy, and on heavy grades the train may be cut in two or three. Also the truck can always be ahead of the cars going either in or out. This allows higher speeds, since the light cars have a tendency to jump the rails when being shoved. Motors also have an especial advantage, in that they

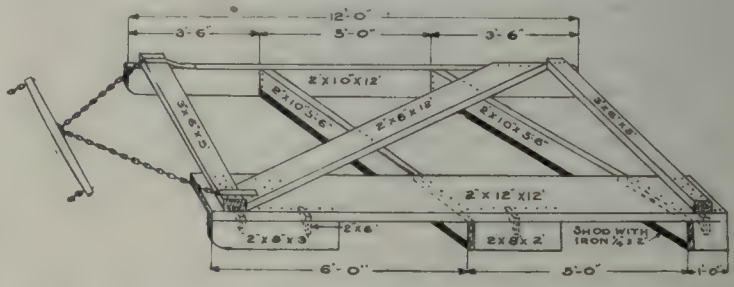
Motor truck replacing locomotive.

are more flexible, and can be used almost anywhere and on any kind of job.

The illustration shows this equipment with the truck hauling a string of cars bearing crushed rock, gravel, and cement for use in the construction of the highway. The truck can pull 24 to 26 tons while running in high gear, and makes ten round trips of eight miles each daily. The operating costs for truck and trailers is about $17 per day.

Road Planer

The accompanying sketch illustrates a type of road planer recommended by the Minnesota Highway Commission for use on gravel or dirt roads. Many gravel roads have a wavy surface which may be completely avoided by the use of this road planer on the subgrade and surface. Where waves have formed they can be eliminated by continuous use of this same implement. The two-blade drag is not at all satisfactory in this respect, as it has a tendency to accentuate any un-



Planer recommended for use on gravel or dirt roads.

evenness, and at the present time there is sufficient evidence of the superior value of the road planer, as shown in the cut, to warrant its use instead of the split-log type of drag. It can be constructed at very little expense. The blades and the outside of the long runner are faced with iron straps to prevent wear and avoid skidding. The strap on the long runner should project ⅛ or ¼ in. below the runner.

To Carry Gutter Water

The cut reproduced herewith illustrates how the water from a road gutter may be carried into a natural waterway by means of a concrete flume. Very often trouble develops through erosion at the point where the road gutter enters a stream or ravine. This can be

Concrete flume for carrying off gutter water.

successfully eliminated by carrying the water to the bottom of the run in a flume. Care must be taken to properly protect the foot of the flume by aprons and rip-rap against underwash. The cut shows an installation of this type, in which a concrete flume is employed.

New Books

Handbook of Highway Engineering.—Second edition—by Messrs. Harger and Bonney. McGraw-Hill Book Company, publishers. Price $3.00 net. This publication contains in a compact and convenient form information ordinarily required in field and office practice of road design and construction. As its title indicates, it is a pocket book for the use of those interested in highway construction and maintenance, giving useful reference data on all phases of road design, building and care.

The present impression is a revision of the first edition, with approximately 100 pages of new material, embodying information in keeping with the most advanced practice in highway engineering. The contents are grouped under two main divisions—Part 1, dealing with the general theory of design, including such subjects as grades, alignment, sections, drainage, foundation, top courses, etc.; Part 2 takes up the practice of design and construction, giving the preparation of reports, specifications, the office and field practice methods of survey, etc. A noteworthy feature is the extensive cost data which cover most of the items necessary for estimating the cost of any ordinary road improvement. This information is carefully classified and tabulated and is compiled from actual instances of road construction. Extensive specifications are included for all the road materials. The handbook also includes mathematical tables. Size about 4 x 6½ ins., flexible leather cover; 609 pages.

Hydrated Lime—History, manufacture and uses of plaster, mortar, concrete; by E. W. Lazell, Ph.D.; published by the Hydrated Lime Bureau; paper cover, 6 ins. by 9 ins.; 95 pages; illustrated. This manual is somewhat of a trade publication and is intended to direct the attention of architects and builders to the characteristics and uses of a comparatively new form of lime, "hydrated lime." So little is known about this material by many builders that the book provides much necessary information in this regard. In it practically all the available data on the subject have been collected in convenient form and use has been made of previous publications and information obtained from the technical press. The history of lime and mortar from the first instance of its use is carefully outlined. The body of the manual describes in detail the chemistry, classification manufacture and slaking of ordinary lime. The reasons for such a material as hydrated lime are pointed out and its manufacture, properties and uses described. The results of many tests on this material and on mortar involving this material, are incorporated. Many illustrations are contained showing structures employing either mortar or concrete of which hydrated lime forms a part.

Mainly Constructional

East and West—From Coast to Coast

The cost of the new dyke at Sea Island, B.C., 6,150 feet in lengths, is $30,220, according to the statement of Messrs Cleveland & Cameron, municipal engineers of Richmond.

The building permits issued in the city of Montreal for the month of July this year show an increase over the same period last year, the figures being $545,670, as compared with $434,490 for July, 1915.

Manager Giberson of the Point Edward, Ont., stone works, is pushing his plant to completion. The machine foundations have been finished, the pillars are up and the roof is under construction.

Representatives of the Grand Trunk Railway and also members of a New York paint concern recently visited Point Edward, Ont., and reports state that they have decided to erect a paint manufacturing plant in that village.

At the annual convention of Canadian Municipalities, held in Montreal, the Hon. R. Rogers, Minister of Public Works, stated that he was hopeful of having constructed, after the war, a national highway from the Atlantic to the Pacific.

The pressure upon the St. John, N.B., city schools, owing to the increase of population, has compelled the school board to prepare plans for the erection of another large school building on Bentley Street. The cost of the new building has been estimated at $70,000.

It is understood that one of the Liberal members of the Parliamentory committee on the construction of the Parliament Buildings at Ottawa has submitted a proposal that settlement be made with the Lyall Company for the work already done and that competitive tenders be asked for the remainder of the work.

The new brick making plant installed at the old brick yard at Mill Creek, N.B., by the Maritime Automobile Co., is now in operation. The capacity of the plant is 25,000 brick per day, when working up to full capacity, and the company plans to manufacture a million brick each season. They also purpose to install a plant for pressed brick and drain tile at a later date.

The discount period for civic taxes at St. John, N.B., expired August 17. The total amount collected was $673,829.31, as against $597,530.94 in the discount period of 1915. The total number of persons who took advantage of the discount this year was 8,060, compared with 7,860 in 1915. The total assessment this year is $835,091.94, an increase of $85,034.76 over 1915.

The work of preparing a draft code of building laws

for the city of Halifax, which had been previously taken up, but dropped a couple of years ago, is to be proceeded with, with a view to having the code complete for presentation to the legislators at the next session. A sub-committee has been appointed to complete the codification and report to the main committee.

Following successful experiments in road-oiling in the city of Ottawa this year, it is proposed by Controller Nelson to initiate for 1917 a general scheme of oiling all the streets in the city that are not paved. Commissioner Macallum favors the plan and a by-law is to be introduced early next year for the approval of the ratepayers, the details being worked out during the winter.

For the four months ending July 31, 1916, the aggregate trade of Canada, including both export and import, has increased more than 100 per cent. over the same period a year ago. During these four months the exports have risen from $159,168,259 to $350,345,305. The imports in the same period rose from $134,729,377 to $249,867,767. These are the figures for domestic imports and exports only.

The engineering camp of the University of New Brunswick is being held this year at the Experimental Farm at the eastern end of Fredericton, where excellent opportunities are offered for carying on practical engineering work in railway construction, traverse, topographic and hydrographic surveys, and field astronomy. Prof. John A. Stiles has charge of the camp this year. August 28 was the opening day.

The plant and assets of the Standard Ideal Company, of Port Hope, have passed into the hands of a new company to be known as the Port Hope Sanitary Manufacturing Company. The capitalization of the new concern is $1,250,000. L. M. Wood, of J. & L. M. Wood, is the president, and R. J. Cluff, president of the Cluff Mfg. Co., vice-president. It is understood that the latter, in conjunction with W. J. Cluff, will manage the business.

On the advice of the Commissioner of Works, Ottawa, Ont., the Board of Control recommended that tenders for pavements be let with a five-year guarantee from the contractors. The Commissioner's view is that any defect will show up in five years, leaving the cost of maintenance for the second five years very light. The council approved, the contracts let being: Westmount Avenue, Cooper Street and Merton Street, to the Ottawa Construction Company.

Mr. J. B. McRae, engineer in charge of the overland pipe construction at Ottawa stated before the city council that he had every reason to believe that the work would be completed before winter. Commissioner Macallum informed the council that in making the estimate of the cost of the distribution system, a number of things had been overlooked, for instance, $60,000 extra had to be provided for valves. It is believed that the work will cost about $150,000 more than was originally estimated.

The port authorities at St. John, N.B., are wondering how they can accommodate all the traffic that is showing up for next winter. Fourteen berths are now available for ocean business, but at least twenty will be required. Of flour, the French Government alone want ten thousand tons per month shipped through this port, while the British Admiralty is making demands which the port will have to meet. It is expected that Pier 16 will be ready for the coming season. The exterior walls have been standing since last year, and the contract for the filling has recently been awarded. Plans for a temporary wooden warehouse, similar to that on Pier 15, are now being prepared. Borings are also being made for an elevator site on the eastern side of the harbor.

A charter was recently granted to the Lignite Briquette & Power Company, and as the initial part of their work the firm commenced the boring of a big shaft in what has been known as the Escana sub-division, just east of the town of Estevan, Sask. These operations revealed a seven-foot seam of fine quality lignite coal and also smaller seams of coal lower down, between which are strata of excellent grades of brick and tile clay. Their first intention was to briquette coal and, ultimately, install equipment for generating and distributing power for commercial purposes, but owing to the prospects offered in the clay-working industry, they decided to first install machinery for the manufacture of brick and tile, products for which it is expected there will be a very large demand in Western Canada during the next few years.

After six weeks of recruiting the 239th Overseas Railway Construction Corps has reached a strength of 450 men. This corps has been formed at the especial request of the War Office in London in order to construct railways at the front, and with the exception of the 500 railroad men that left Canada under the command of Col. Ramsey, it is an entirely different unit to any other that has been raised in the Dominion. Lt.-Col. T. W. Stewart, of Messrs. Foley, Welsh & Stewart, the well-known railroad contractors, is in command of the corps. As soon as he was requested to undertake its formation he went over to England and France to learn first hand exactly what was required. The organization calls for bridge-men and carpenters, platelayers and teamsters, blacksmiths, fitters, enginemen, laborers and eight complete train crews. Each company will be a separate unit in itself, and the full strength will consist of about 1,100 men, including 31 officers. Lt.-Col. Stewart was chosen to command this corps on account of his extensive railroad experience. He has recently built over 5,000 miles of railway in the West, as well as the Rogers Pass tunnel. The officers have also been selected for their knowledge of railway work, and many of the men who have joined were personally working for Col. Stewart. Word has been received that the unit is urgently required at the front and orders have been issued to commence active recruiting to bring it up to full strength.

Personal

Mr. Joseph Race, city bacteriologist of Ottawa, has been given control of the dosage for the hypo treatment of the city water.

Hon. B. Frank Smith was recently appointed Minister of Public Works of the Province of New Brunswick, actively assuming control of the department on the 18th of this month.

Obituary

John Holmes, one of the old residents of the east end of Toronto, died recently after a short illness. Mr. Holmes was a native of Cambridgeshire, England. He came to Canada at the age of seventeen, settling in Stratford, where for many years he was a prominent contractor and also chairman of the Board of Works. For the last 43 years he has been a well-known valuator in Toronto.

The death occurred recently at Brockville, Ont., of James D. Powell, in his 72nd year. Mr. Powell was born in Brockville, and upon attaining manhood he moved to New York City, where he engaged in business as a building contractor. Many structures in and around Manhattan bear evidence of his skill and ability.

Mr. J. A. Davis recently passed away at his home at 54 Frances Street, Winnipeg, aged 81 years. Mr. Davis was born in New York. His early life was spent in Ontario, and in 1882 he went west, locating at Winnipeg, where he entered into the contracting and building business.

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Day vs. Contract Labor

THE question of day labor vs. contract is still being discussed in Montreal. The Trades and Labor Council is strenuously defending day labor for civic works, on the ground that the system is more beneficial to their interests. It is admitted that certain abuses exist, but it is argued that these are capable of being remedied, and that, with these amendments, the system is an ideal one. Controller Villeneuve has vigorously attacked the method as wasteful and, under present conditions, prejudicial to the interests of the men. He strongly advocated the extension of the plan referred to in our issue of August 9, by which the city will submit tenders in competition with contractors. This is already done in certain classes of work, and the city has been able, in many instances, to underbid contractors.

"I have never objected," says Mr. Villeneuve in a communication to the Trades and Labor Council, "to the city carrying on its own works, but I have asked, and I again ask, that the city tender each time it is decided to execute important works. In this manner we would be in a position to prove the exact cost of the works, to prevent the estimates voted for these purposes being exceeded beyond reason, and to ensure competition in municipal works from which the taxpayers could not but benefit. A city of Montreal's importance should have the same privilege of action in the execution of its public works as the provincial government, the government at Ottawa, and even other cities in Canada. Have you criticized the policy of our government and of those other cities who at all times ask for tenders for the execution of public works?"

Mr. Villeneuve also states that, while the system of executing municipal work by day labor has its good side, yet, under the present conditions, it has produced deplorable results.

Twenty Societies Under One Roof

THE American Society of Civil Engineers have decided to move their headquarters into the Engineering Societies Building, New York, which will make a total of 20 engineering organizations with headquarters now located in this building. The total membership represented amounts to over 50,000, the names of the various societies and their membership being as follows:

American Society of Civil Engineers	8,022
American Institute of Electrical Engineers	8,308
American Institute of Mining Engineers	5,597
The American Society of Mechanical Engineers	7,149
Aeronautical Society of America	200
American Society of Heating and Ventilating Engineers	705
American Gas Institute	1,530
Association of Edison Illuminating Companies	73
American Institute of Aeronautical Engineers	121
Empire Gas and Electric Association	115
Illuminating Engineering Society	1,350
Municipal Engineers of the City of New York	600
National Electric Light Association	14,000
National Association of Engine and Boat Mfrs.	175
New York Electrical Society	705
Society for Electrical Development	1,128
Society of Naval Architects and Marine Engineers	900
Society of Automobile Engineers	1,975
U. S. Naval Consulting Board	24
Total	52,677

The idea of a closer affiliation of engineering societies, which must follow from this course, is an excellent one. We in Canada might well have our engineering society buildings in our various cities. Union is strength, and there is no doubt that the physical as well as the moral force of all our engineering bodies would be increased very considerably if they could all meet together at one point and, as occasion required, discuss subjects of common interest on common ground.

Guarding Vancouver's Water Supply

THE pure water for which Vancouver is famous is piped from glacier-fed streams in the mountains back of the city of North Vancouver. One of these pipe lines borders the famous Capilano Canyon in places, and, in consequence, is exposed to particular danger in time of freshets. In the spring

season it is not unusual for the Capilano River to rise ten or twelve feet in as many hours, and where there is room for the great body of rushing water to spread, the "scour" is tremendous. New channels are cut after the fashion of the Mississippi on a rampage, as described by Mark Twain, and a couple of years ago City Engineer Fellowes saw that at one spot nearly opposite the Capilano Hotel a deviation of the main stream threatened to undermine and carry away a section of the pipe line. Should this occur at a time when Vancouver needed the full pressure for fire purposes the consequences might mean the loss of millions in property.

The force of the current having occasioned the damage, Engineer Fellowes determined if possible to employ the same agency in the making of repairs so as to save money for the city. This he accomplished by forcing the turbulent stream to cut for itself a new channel, thereby removing the tremendous pressure that was threatening the safety of the main. As may be imagined, the work involved some very anxious days and nights for the engineer and his staff of workmen, owing to the possibility that the formation of a boulder dam or riffle in the new stream way might throw the current back into the old channel. Nothing of the kind happened or threatened, however.

In order to protect the section of pipe line at that point from any future danger of water erosion an extensive system of protective cribbing and bulk-heading was put in, the necessary timber being secured close at hand. The work has been carried out in the best possible manner, and, when recently inspected by the City Council, the aldermen paid their engineer some well-deserved compliments.

The Final Link in Quebec Bridge

September 11 has been fixed as the date for the floating in of the last span of the Quebec Bridge. Every precaution is being taken to assure that the work will be carried out without interruption. In the nature of things, the date can only be provisionally fixed, as the floating in of the span is absolutely dependent upon favorable weather conditions. Should conditions be unsuitable, the work will be postponed. The span will be floated on scows from the bank of the St. Lawrence, three miles below the site, to midstream, and from there to the bridge. The span, weighing just over 5,000 tons, and the largest single span in the world, will be raised 150 feet into position by means of 1,000-ton jacks. A special delegation of the members of the Canadian Society of Civil Engineers will be among the visitors.

Wide Responsibilities of Employer

In the province of Alberta it looks as if, under the Workmen's Compensation Act, the employer is to be held responsible for the ill effects of the weather. A laborer sued under the Alberta Workmen's Compensation Act for damages for an accident while working for a railway construction company, alleging the following facts: The plaintiff was chopping with an axe under the orders of a foreman in cutting a roadway for teams working on the construction of a railway right of way, his hours being from seven a.m. to six or seven p.m., during which time he was not under shelter. On the day of the accident the temperature was about 60 degrees below zero. On his return to camp after being exposed all day it was found that his feet were very badly frozen, notwithstanding that he was wearing two pairs of woollen socks and a pair of felt boots and rubbers, though the boots were not in a very good condition. It was contended that when the plaintiff met with the accident he was a workman within the meaning of the Workmen's Compensation Act, and that the injury occurred from an accident arising out of and in the course of his employment. It was shown that the frost bite, as it happened in this case, was an accident within the terms of the Act, and it was also found that the plaintiff was, by reason of his employment, exposed to a greater risk of frost bite than any other person. Judgment was given in favor of the plaintiff, and an appeal entered by the defendant company was dismissed with costs.

Practical Course in Concrete

Wentworth Institute, Boston, is about to add to its courses of instruction one on practical concrete work, having for its object the training of young men for the work of concrete foremen and contractors. The Institute has set aside one of its best laboratory rooms for this concrete course, and is fitting it up with modern testing machinery and other necessary equipment to make possible various determinations that will illustrate the technical as well as the practical sides of the applications of concrete. This work has been made possible largely by the co-operation of the Portland Cement Association, the work having been planned by its extension division.

Canadian Society Will Report

In accordance with the promise of the Montreal Board of Control, a committee of electrical engineers, members of the Canadian Society of Civil Engineers, have been supplied with information in reference to the proposed hydro-electric development, concerning which there has been so much controversy. This committee will make a report, without cost to the city. In the meantime the city engineering and the waterworks departments will ask manufacturers of turbine wheels to submit proposals for the equipment of the power house. These proposals will be reported on by a consulting engineer prior to calling tenders.

Good Roads Congress in Halifax

A good roads congress is to be held in Halifax between September 13 and September 21. Mr. G. A. McNamee, secretary of the Dominion Good Roads Association, has accepted an invitation to attend and to give his advice regarding the programme and the general arrangements.

Concrete Sewer

There has just come to hand a little pamphlet issued by the Portland Cement Association, entitled "Concrete Sewers," describing the advantages of this type of sewer and its widespread use and application. A number of letters are included from various city engineers expressing their satisfaction with concrete in this regard. Recommendations of the association regarding the manufacture of concrete pipe are included, which, if followed, will enable a high quality product to be obtained. Numerous illustrations are reproduced showing installations of concrete sewers. The booklet is issued as a part of the publicity campaign of the association, whose object is to acquaint people with the advantages of cement as a building material.

Water Supplies for Towns and Cities

A General Article Describing the Sources, Character of Impurities and Diseases Carried by Water—Methods of Purification

By John W. S. McCullough, M.D., D.P.H.*

Before an audience such as this one it is unnecessary to point out the value, to an individual or to a community, of a safe and adequate water supply.

It is proposed in these remarks to consider briefly some of the important points in reference to the source of water supplies, the kind and character of the impurities in water, the means provided by the authorities for detecting these impurities, the diseases which may be carried by water, and finally the means whereby water may be rid of its impurities and water-borne diseases prevented.

Sources of Supply

The original sources of all water are the snow and rain, which falling upon the earth finally sink into the ground, and become a reservoir of supply, or which are found on the surface of the earth as creeks, rivers, ponds and lakes.

Shallow Wells

The simplest artificial water supply is obtained from shallow wells of from fifteen to fifty or sixty feet in depth. The supply of these is maintained by the ground water which is replenished by the rain. These wells, in the absence of any source of pollution such as manure, the proximity of water-closets or cesspools, and if adequately protected against surface pollution, often give excellent water. Wells are the main supply of most farm homes in the rural districts. This fact is perfectly familiar to all of you, but it is not so well known or at least, if known, the knowledge is not turned to practical account, that nine out of ten of the country wells are open to pollution because the simplest forms of protection of the well against pollution are not utilized. I should like in these remarks to say something which you may carry away with you and apply in a practical way when you return to your several communities, and nothing which I can say will be of any greater value to you if you will make use of it, than this; if you use well water see that you keep filth away from and out of the well.

Last year when the military camp was maintained at Niagara, an analysis was made under my direction of the water in the wells in the Niagara peninsula within a radius of seven or eight miles from the camp and of those along the roadway leading to St. Catharines, to Hamilton, thence to Toronto, which was used by the troops in their weekly route marches and in the trek from the camp to this city. In all this area and over a route of nearly ninety miles from the camp to Toronto, the number of wells that were unpolluted could be counted on the fingers of one hand! This is a strong statement, and I could scarcely have believed it were it not that proof positive of this assertion was secured. What is the reason for this extraordinary condition? It is chiefly because the top and sides of the well are not protected against the admission of filth. In most cases the well is lined by brick, stone or boards, and the top covering is filled with cracks through which all manner of impurities may readily enter. How may this be prevented?

Very simply; it is only necessary to make the lining of brick, stone or wood impervious to the entrance of these impurities by cementing or otherwise securing the joints and by having the covering constructed of concrete or boards whose joints are leaded. The greatest danger is in the first few feet at the top of the well, and in the top itself, which should be carried well above the ground.

The well should be placed at a sufficient distance from and in the opposite direction of the drainage of barnyard, closet or kitchen sink. Imagine what may happen if the excreta from a typhoid case is thrown on the ground or upon the manure heap whence it may drain into the well or be carried by the boots of the farm hands or the feet of animals to the open top of the well! It is almost certain that there will be a further outbreak among the users of this water. Many epidemics of typhoid start in this simple manner.

The Artesian or Deep Well

This is one of the safest waters. Coming as it does from a great depth of, say, 100 feet or more, it is cool, and having been filtered through the earth it is usually of excellent quality. This is the greatest asset of the new military camp, lately established at Borden in Simcoe County. The water of this camp comes from a series of wells sunk to a depth of from 90 to 120 feet. The water obtained from artesian wells is found there because the rains passing through the pervious sand and gravel are held by an underlying impervious stratum of clay or rock and flow to the surface because of subterranean pressure, resulting from the weight of superincumbent rock or earth, the pressure of imprisoned gases or the formation of the underground layers giving hydrostatic pressure. Water from artesian wells often travels considerable distances.

The iron pipes lining the well should be screwed together and the top of the pipe raised above the ground. For a few feet down, the pipe should be surrounded by concrete in order to afford protection against surface impurities trickling down its sides.

Springs

These are outcroppings of underground water flowing along a hard stratum and appearing in the sides of banks or hills. The spring is popularly looked upon as a safe water. One often hears the remark "This is spring water" made in such a manner as to indicate that the water is above suspicion. Spring water may be very good, equal to the best, or it may be the very worst. All depends upon the surroundings. At Niagara when the camp opens in May the numerous springs flowing out of the bank a short distance back from the river are mostly of good quality. In a couple of weeks after the troops arrive actual analysis shows them all polluted. The opportunities for pollution from the increased population upon the Niagara common have had their direct and natural effect. If spring water is to be kept safe the chances of pollution by human habitation must be closely observed and frequent tests made. Springs outcropping

*Before Annual Meeting of the Ontario Municipal Association, August 28th, 1916.

from deep sources are safer provided the overlying soil or rock is not fissured, in which case the chances of pollution are much increased. If springs are used the outlets should be cleaned up and protected against local contamination and the area surrounding the spring secured against any possible pollution.

Rain Water

Rain water draining from roofs forms a source of supply in many localities. Cities like New Orleans used to depend upon this source almost entirely. If used, this first run-off from the roof should be discarded. The reservoirs or tanks should be kept thoroughly clean and so protected that mosquitoes may not reach the water and breed therein. Rain water is open to so many chances of pollution and the supply so irregular that it is not highly regarded as a source of water supply. Its use can only be justified on the plea of necessity.

Rivers and Streams

These form the source of water supplies for a large proportion of our cities and towns. If protected against impurities, such as sewage, and are not too discolored or turbid they are frequently excellent sources of supply. Unfortunately it has become the habit to use the river or stream for the double purpose of a sewage disposal as well as a water supply. This necessitates the most complete purification of the water if it is to remain a safe source of supply.

Lakes and Upland Sources

Natural and artificial lakes, the latter being usually called impounding reservoirs, are very common sources of supply. Lake Ontario maintains its supply from the rainfall upon the surrounding country draining into it and from the overflow from the Great Lakes and rivers to the west and north which in turn gain their supplies from the country drained by them. In many places, especially in England and Scotland and in several instances in the United States, the impounding reservoir is made use of. The cities of Manchester, Glasgow, Liverpool in Britain, New York and San Francisco in the United States are examples. Supplies of this class are gained from large areas of mountain or waste land and the greatest care is taken that the sewage from human sources does not contaminate the drainage area. For example, the uplands comprising the watershed of Manchester's supply is used for shooting only and all the wastes at the shooting lodges are carefully carted away in barrels so as to eliminate any danger of pollution of the water.

Large lakes, such as Lake Ontario, are invariably good sources of supply. They are, of course, subject to contamination in the neighborhood of cities, but the supply is ample and they may readily be purified. One commonly hears uncomplimentary references to the water supply of Toronto, and the remark "Why don't we get water from Lake Simcoe?" To these remarks I might reply by saying that with the completed system of purification now being established by the city our water supply will be second to none. Lake Simcoe as a supply for Toronto is not to be compared with Lake Ontario, because:—(1) It is a smaller body of water; (2) it is at a considerable distance, which would increase its cost; (3) it drains a thickly populated country and its comparatively small volume is unable to satisfactorily dispose of the wastes which empty into it.

Lakes and impounding reservoirs if adequately protected against contamination, or if excessively contaminated, then adequately purified make, like rivers and streams, first-class sources of water supply.

Impurities in Water and Diseases Carried by Water

The quality of a water for public or private use should be palatable and if possible free from color, turbidity, or sewage contamination. It should be moderately soft. If it contains much acid, as will be found in peaty waters like that of the Ottawa, or if carbon dioxide is present in large quantities danger will ensue because of the action of such ingredients on lead pipes. The greatest danger is, of course, from the pollution by sewage, that is, by the entrance to the water of excreta from the human body and the consequent danger of spreading such diseases as cholera, diarrhoea, dysentery and typhoid fever. All of these are readily carried by water infected with the germs of these diseases.

Excessively hard waters spoil the flavor of vegetables cooked in them. They are unsuitable for laundry use as they "iron mark" clothes. When soap is added to certain "hard" waters an excessive amount has to be used. The city of Glasgow, it is estimated, saves $180,000 annually in soap since the introduction of Loch Katrine water.

Color is objectionable for appearance's sake if for nothing else, and if peaty material is in solution in the water it requires a special means of purification.

Turbidity is due chiefly to insoluble matters, such as clay. This also requires special treatment for its removal.

Analysis of Water

In this province the government has for some years provided for the free examination of public and private water supplies. Sterile bottles are supplied by the Provincial Board of Health and outside of the larger cities where municipal laboratories are provided the work of water analysis is extensively carried on at the laboratories of the Board in Kingston, London, and Toronto. In this manner there are approximately 2,600 bacteriological and 100 chemical samples of water examined annually. While this is of enormous advantage to the public, yet it is always safer to have a local laboratory connected with a water supply wherever possible in order to check daily or oftener any possible chance of pollution.

Purification of Water

Like everything else, prevention of water pollution is safer than purification. In selecting a water supply every known source of pollution should be avoided, and having secured an adequate supply the most rigorous measures should be taken to protect it against the entrance of human excreta. A stream, a well, a lake or any other source may be safe 364 days of the year. In the remaining day the influx of the excreta of a typhoid patient may infect large numbers of people. This is not the time to seek protection or to have the water analyzed. The proper time is to anticipate such a danger by timely protection and frequent tests of the supply. It would be amusing if it were not so dangerous to receive as the Board sometimes does the complaint of a Board of Water Commissioners that the Medical Officer is "knocking" the water supply, because, having learned from the Board's analysis that the tap water shows the colon bacillus in 1 cc. of water, he has advised the townspeople to "boil" the water. The Water Commissioners may not be to blame for the contamination of the water, though they

sometimes are, but they are criminally negligent if they try to hide the facts.

Means of Purification

The simplest method of water purification is by boiling. Obviously this method can only be carried out on a small scale, as in a family, but in the face of an epidemic, say of typhoid, it is often of the greatest value.

Chlorination

This is a cheap and quite effective means of water purification where elaborate methods cannot be established either because of urgent necessity or for financial reasons. Two methods are in common use, namely: by the use of calcium hypochloride or bleach, or by the use of liquid chlorine. Waters which are turbid or contain a large proportion of coloring matter require larger doses of chlorine for their disinfection and are apt to be distasteful to the users.

There is no evidence that the use of chlorine is in any way injurious to the users of the water so treated. Indeed the largest doses used in chlorination are so small in the individual daily supply used as to be almost infinitesimal. While this form of treatment is not the ideal one, it is most useful and satisfactory, and has no doubt saved many lives and a vast amount of illness to the users of otherwise dangerous water.

Ozone

The ozone treatment of water has not come into use to any extent on this continent. It is used on a large scale in some cities of Europe. The most extensive plant is at the Saint Maur Waterworks, Paris. The gas is generated by electrolysis and the water is first filtered by means of open slow-sand filters. Ozone gas is a powerful disinfectant, causing a reduction of 99 per cent. of the bacteria. The engineer in charge of the Paris works assured me that, while ozone gave good results, it was expensive, and in his opinion, no more efficient than chlorine. The water so treated must first have suspended matters removed by sand filtration.

Slow-Sand Filtration

This is sometimes known as the English method. When polluted water is passed slowly through sand, that is, at about the rate of three or four million gallons per acre per day, the suspended matter is removed. Discoloration due to peaty matter remains largely unchanged by this method. Along with the suspended materials in the water the bacteria and other micro-organisms are removed in a remarkable manner. One would, at first thought, conclude that the process is a mechanical one, that is, a straining out of the suspended matters by the sand layers. It is something more than this. When a sand filter is first installed the filtered water is not nearly so well purified as when the age of the filter is increased. Why is it that water passing slowly through a sand filter is prified? Some of the purification is due to oxidation of the organic matter, that is, by means of chemical action, but the greater portion of the efficiency of a filter is due to the action of living micro-organisms. The results of purification continue up to the point where the flow of water becomes so small that the sand has to be cleaned. This is done by scraping off the top ½ to 1½ inches of sand when the flow of water increases and the efficiency is maintained.

In consequence of the passage of water through the sand the suspended matters are intercepted in the upper layers. Here a jelly-like deposit forms, and in addition an appreciable action of a similar character takes place in the depth of the filter. This is due to the growth of the bacteria derived from the sand and water, the slimy matter being formed by the bacteria themselves and the exudation from them.

This organic matter accumulates more readily in summer than in winter, because warmth favors bacterial growth. Consequently, sand filters are not so efficient in cold climates and require to be covered as a protection against cold and frost.

The sand used should be clean river, beach or bank sand, with either sharp or rounded grains. It should be free from dirt, clay or organic impurities—being washed if necessary to remove these impurities. Fine sand is more effective and it should not contain more than two per cent. by weight of lime and magnesia, as an excess of these chemicals hardens the water.

Slow sand filters are usually constructed in the form of concrete chambers with under drains to carry off the filtered water. Overlying the under drains is a layer of coarse gravel and upon this two or three feet of sand. The water is applied to the surface of the sand and filters through it at the rate already mentioned of two or three million gallons per acre per day. If the filter is forced, that is, the rate of flow carried to five or six million gallons per acre per day, its efficiency is lessened and the filtered water will be inadequately purified.

In some filters, notably like those in Philadelphia, where the water used is from muddy rivers, a rapid sand filter is used as a pre-filter. This lessens the load on the sand filter and prolongs the period between the necessary scrapings. In scraping one-half to one and a half inches are removed. This sand is washed, dried and replaced. The period between scraping varies according to the character of the raw water, the fineness of the sand and upon the maximum allowable loss of head. It may vary from a few days to five or six weeks.

Rapid Sand Filters

This is known also as mechanical filtration or the American filter in contra-distinction to the slow sand type which is frequently called the English filter. It is similar to a slow sand filter in that the filtering material consists of three or four feet of sand, but in other respects the construction and operation are entirely different. In a rapid sand filter the rate is from 100 to 125 million gallons per acre per day. A coagulant such as alum or sulphate of iron is used to precipitate the suspended matters and the washing of the sand is entirely different. In addition the area required is relatively small and while the cost of construction is less than that of a slow sand filter the cost of the maintenance and operation are greater. There are specially constructed basins for coagulation and sedimentation, and the washing of the sand is carried on every four or six hours. The cleaning is done by a reverse flow of water and by agitation of the sand by mechanical devices or by compressed air.

Comparison of Results

When properly constructed and operated, the results obtained are essentially the same. There are very many plants of this type in cities of the United States. Invariably excellent results are secured. Very badly polluted, muddy or colored waters are, by the operation of this type of filter, so purified as to be

first-class supplies equal in every respect to the finest class of water produced anywhere.

The points I desire to emphasize in these remarks are:—

(1) First and most important—the necessity of the prevention of the contamination of our natural water supplies.

(2) The protection against pollution of any source of supply.

(3) In the selection of a supply its whole history, environment and character should be investigated.

(4) Protection of the public against water-borne diseases, such as typhoid fever, by rigid protection and daily analysis of the water used.

(5) Prevention of excessive waste of water and consequent increased cost of metering, careful plumbing and avoidance of defective piping.

(6) When a purification plant has been established it must not be allowed to run itself. It must have careful supervision if proper results are to be obtained. It costs money to provide pure water for a city or town.

A smaller outlay in this respect would often be avoided and undue delay in the installation of a satisfactory supply prevented if the public had some real knowledge of the simple facts I have endeavored to present to you.

Waterworks System of Peterboro City

THE waterworks system of the city of Peterborough is a direct pumping one, there being no reservoir or standpipe. The pumping station is situated on the Otonabee River, about 2¼ miles above the centre of the city, where a massive concrete dam has been constructed to develop the power to run the pumps.

The pump house occupies the western end of the dam, and is of concrete and brick construction, thoroughly fireproof. Together with the dam it was constructed in 1909 by the Bishop Construction Company, and was designed by William Kennedy, jr., consulting engineer, of Montreal. It measures 125 ft. by 40 ft., and is steam heated and electric lighted. A five-ton travelling crane serves the pumps, which are placed on the main floor.

There are five sets of pumps, of which the first two are triplex, single acting, horizontal plunger type, built by the William Hamilton Company, of Peterboro, and are rated at 2,225,000 gallons per 24 hours at 130 pounds pressure. These pumps were built in 1893, and were originally installed in the old pump house, just above the site of the present one, being moved into the new one on its completion. After nearly 23 years of continuous service they are practically as good as new, and the maintenance is infinitesimal. Judging by their present condition, if not overtaken by obsolescence they will be running fifty years from now. They are slow moving (20 r.p.m.) and of massive construction, which will largely account for small depreciation.

The third set is of the same style and make, but is rated at 3,000,000 gallons per 24 hours. It was installed in 1909.

The fourth set is a Worthington three-stage, centrifugal pump, rated at 3,000,000 gallons per 24 hours, and was built by the McDougal Caledonian Iron Works, of Montreal. It was installed in 1909.

These four sets are directly connected to Samson waterwheels, built by the William Hamilton Company, of Peterborough, the first two having 62-in. wheels and the others 68-in. The first three sets use bevel gears to transmit the power, and the latter a speed increasing gear, which increases the speed of the waterwheel, 80 r.p.m., to that of the pump, 640 r.p.m.

The fifth set consists of a single stage centrifugal pump, driven through reduction gears by a De Laval steam turbine. It was supplied by the Turbine Equipment Company, through the De Laval Dairy Supply Company, of Peterborough, and is rated at 6,000,000 gallons per day.

Waterworks Pumping Station at Peterboro, Ont., showing dam on left and power house on right.

This set was installed in 1915 as an emergency pump, to be used at times when the waterwheel-driven pumps cannot be used. Like all water power plants in this locality, there is considerable trouble in the winter from anchor and frazil ice, and sometimes the pumps have been shut down for considerable periods. During the winter of 1914-15 this occurred three times, with an average shut-down of 10 hours, which was a very serious matter. After carefully investigating various schemes for mitigating this evil, such as

steam-heated racks, covered forebay, etc., the commissioners decided to install a steam pump and be independent. A confirmation of their judgment was seen during the past winter, the first since the unit was installed. No less than five times was the unit called into service on account of the plugging of the water-wheels with ice, and by its means an uninterrupted supply of water was given to the consumers.

In the basement of the pumphouse, running the length of the building, is a pipe gallery. Two rows of pipes extend from end to end, one of these being the suction header and the other the discharge.

The suction header is connected with each pump, and receives a supply of water from an intake pipe extending above the dam. The discharge pipes of all the pumps are connected with the discharge header, which contains a venturi tube for measuring the pumpage.

The necessary valves for the proper control of the different pumps are situated in the pipe gallery, together with the condenser and vacuum pump for the steam unit.

The boilers for the steam unit are installed in an addition built to the south of the main building. There are two 100 h.p. horizontal return tubular boilers, made by the William Hamilton Company, and are equipped with Cyclone shaking grates.

Induced draft is supplied by a fan driven by a small vertical steam engine, and by its use steam can be speedily generated. A gasoline engine is also connected to the fan, and is used to operate it when the boilers are cold and there is no steam for the fan engine.

A Cochrane feedwater heater and the necessary boiler feed pumps are also installed in the boiler house, and there is storage for 75 tons of coal.

In the office, on the ground floor of the main pumping station, is the recording apparatus of the Venturi

Interior of Main Floor of pump house looking east, showing set No. 1 in foreground.

meter, which was supplied by the Builders' Iron Foundry Company.

While the river water at Peterborough is very good on the average, at certain times of the year it becomes dangerously polluted, due to the sewage from the summer resorts in the lakes above and also to the presence of river drivers on the river in the spring and early summer.

The Ontario Board of Health saw fit this spring to order the installation of a chlorinating plant as a precautionary measure; and, after investigating several methods and styles of plants for the purpose, a contract was let by the commissioners for a liquid chlorine apparatus to Wallace & Tiernan, of New York. The apparatus supplied is known as their type B, solution feed, automatically controlled equipment, and was placed in operation June 1 of this year.

Owing to the variable character of the water, the dose is adjusted to suit conditions. At present the dose is 1.75 pounds per million gallons, but this will

Interior of main floor of pump house looking west, showing steam unit in foreground.

be reduced as soon as the bacterial condition of the water warrants it.

The apparatus is connected with the Venturi tube in such a way that variations in the flow of the water are instantly followed by variations in the flow of the chlorine, so that the water does not become overdosed at some times and underdosed at others, as is often the case with manually controlled plants.

The chlorine gas is continuously dissolved in a small amount of water, and the resulting solution piped to the point of application on the intake pipe, and in passing through the pumps it is thoroughly mixed with the main body of the water.

The chlorinator is compact and reliable, and has the great advantage that there are no moving parts to get out of order.

The Peterborough waterworks was first installed in 1882 by a private company. In 1902 the plant and distributing system were bought by the city and put in charge of a waterworks commission. Mr. T. F. Matthews, the present chairman, has occupied that office since the formation of the commission, and one of the commissioners, Mr. W. H. Moore, has been a member since 1903. The other member is Mr. Robert Hicks, who was elected in 1914, to fill the vacancy left by the retirement of Mr. W. H. Hill, who had been a member since 1902.

The Peterborough waterworks is a shining example of what intelligent commission government will do for the utilities of a city. No doubt much of the success of the Peterborough commission is due to the fact that there have been so few changes in its personnel, and the splendid plant built up by them is a substantial monument to their vision, adaptability, and general business and executive ability.

The present superintendent is R. L. Dobbin, B.A.Sc., under whose supervision the auxiliary steam plant and the liquid chlorine plant have been installed.

New Entrance to Toronto Exhibition

Chief Feature is New Bathurst Street Bridge and Approaches. Steel Structure on Concrete Abutments

AFTER many years of patient waiting, a new eastern entrance scheme for the Canadian National Exhibition was started this spring, and has just been completed. This work involved a new trolley line following Bathurst Street to the Old Fort grounds and thence westerly to the new entrances just west of Strachan Avenue.

One of the necessary features of the new scheme was a new bridge crossing the railway tracks at the foot of Bathurst Street, to replace the antiquated and dilapidated steel structure previously located at that point. This bridge was the only difficult part of the entire project, the rest involving simply the construction of a track bed, with a small trestle bridge near Strachan Avenue. The accompanying illustrations show the Bathurst Street bridge in course of erection. This new structure was made necessary because the old steel bridge was not large or strong enough to bear the increased loads, besides which the steel work was beginning to to show signs of corrosion and wear.

Fig. 1—Placing a top chord member in new Bathurst St. Bridge, Toronto.

The new bridge is of a standard steel, riveted-truss type, of 202 ft. span and 66 ft. wide, with 22½ ft. clearance between the floor and track. The trusses are the same ones as were employed in the old Grand Trunk Railway bridge spanning the Humber River, which was replaced with a plate girder bridge when the Lake Shore Road separation was effected some years ago. The Grand Trunk Railway Company, who jointly erected the bridge with the city, thus made good use of these old trusses by erecting them on the Bathurst Street bridge. For this work the trusses were entirely disassembled and re-erected anew. The floor span was widened and a new floor system evolved with increased bracing capacity to correspond. The steel work was built up on false work, and no methods were employed that were in any way out of the ordinary. The abutments are four in number, and are constructed of reinforced concrete. A point of interest is that the location of this new bridge is merely temporary, and for this reason three of the four piers are not permanent. At present the lower end of Bathurst Street is diverted to pass a packing house that is located on the street alignment. For this reason the bridge is obliquely located. The street railway right of way is also temporary. It is the intention, when the Harbor Commission finishes its work, to re-align Bathurst Street and to have the car tracks enter the exhibition grounds along the lake shore, so that the present location of the bridge and trolley line is merely to tide over a period of a few years. One abutment of the bridge has been made permanent, and when the re-location is effected the whole structure will be pivoted about this point and re-set on new piers.

The southern approach to the bridge is on wood trestle-work, since this will be changed when a new location is made. The bridge floor is of reinforced concrete, and concrete sidewalks are also laid. The accompanying illustrations show the salient features of the new structure. In Fig. 1 the erection of the steel work is illustrated with the traveller placing a top cord member. All the units of the trusses shown belonged to the Humber River bridge. In Fig. 2 the steel work is practically complete. The false work on which the erection took place is clearly seen. Small concrete posts for supporting the trestle approaches are shown in the right foreground. The trestle approach on the south side, supporting the car tracks and roadway, is shown in Fig. 3. The form of abutments can be seen, those that are shown being merely temporary, to be abandoned when the bridge is straightened out.

The clearing of the site began in March, and the work was completed for traffic on August 25.

Fig. 2—Steel work nearly complete. Trestle foundations in foreground.

Fig. 3—South approach, showing trestle work to carry the roadway.

More General Use of Concrete Sewers

WITHIN recent years, concrete has been more extensively employed as a material for the manufacture of sewer pipes. In many cases, sewers of this type have advantages that cannot fail to impress engineers with the superiority of concrete for this purpose. This material has many well-recognized merits, of which one of the most potent is the fact that it is a home-made product, made, as a rule, of local materials and placed by local labor, so that little expenditure is involved outside the locality in which the work is progressing. Unskilled labor at lowest cost can very often be used, reducing the expense to a very considerable extent. Municipalities have found by experience that concrete sewers, more especially in the larger sizes, are much lower in cost than brick or tile and are just as durable and satisfactory.

Concrete for certain kinds of sewers has given eminent satisfaction and city engineers express much appreciation of its advantages. In either monolithic or pipe form, it has been used quite extensively. The objection which is usually advanced is that concrete is unable to withstand the effect of acids which sewage normally contains. Many cities are using sewers of this type for sanitary purposes, however, and claim that the force of this argument is doubtful. The statement of a well-known consulting engineer in regard to this matter is important. He states that:

"There does not seem to be any reason why concrete does not form one of the most admirable materials for the construction of sewers. I have seen concrete sewers in which the discharge waters of manufacturing plants have flowed through them containing a great quantity of acids and one would reasonably suppose that the surface of that sewer would be softened and disintegrated, but there seems to be a saving grace for the sewer in that the oily matters and scum that is to be found in sewage coats the surface of the sewer and renders it immune against action. In most of the sewers that I have examined, the original surface was intact and in a better state than when originally laid."

This authority states that there seems to be no need of fear in this respect provided means are used to get the best results and that the concrete is thoroughly hardened. If this is properly carried out it will be as satisfactory as a vitrified material.

The life of concrete is of more or less conjecture, since its use has been restricted in most cases to the last few years, although experiences with regard to old concrete seem to indicate a durability comparable with that of brick or tile.

Concrete sewers are made in either pipe or monolithic form, and municipalities have been employing both varieties according to local and structural conditions.

Concrete Pipe Sewers

Many types of concrete sewer pipe are manufactured. These differ, however, principally in the methods used to form joints and in the manner of reinforcing the pipe. Some types of pipe are circular in form, some oval, some have a combination of oval and flat section, some are hand, and some machine-made. Various methods, some of which are patented, are used to form joints. Some pipes have bell and spigot ends, others have plain ends which interlock in various ways, usually provided for when the pipes are manufactured. Which type or types should be used is perhaps largely a matter of individual preference and the conditions encountered in the excavation, although the subject of quality is one upon which there should be no difference of opinion.

Regardless of their form or type, the value of concrete sewer pipe lies largely in its quality, and this is dependent entirely upon observing proven requirements of manufacture, which include proper materials, correct manufacture and careful hardening. A large proportion of the final success depends on this last factor.

Experience has shown that cleanliness of the sand and pebbles or broken stone, which means freedom from clay, loam or crusher dust, has a great influence on the quality of concrete sewer pipe. No compromise should be made in the matter of clean, well-graded materials; it is more important perhaps in sewer pipe manufacture than in some other uses of concrete—just as important as requiring that the cement used shall meet standard specifications. When the material to be used comes from a gravel bank or similar deposit, it should be examined to determine cleanliness and grading. The natural run of such material is not to be relied upon. It must be screened and the sand and pebbles properly proportioned. If the aggregates contain more than three per cent., by weight, of fine matter ordinarily classed as dust, silt or clay, the presence of such material will invariably lower the quality of the resulting concrete. If crushed stone is used, it also must meet the requirements of grading and cleanliness mentioned for pebbles. The tendency to use an excess of fine material is particularly to be avoided because of the consequent reduction in strength of the finished pipe.

In reinforced concrete pipe enough water must be used in the concrete mixture to make certain that there will be a perfect bond between concrete and reinforcing metal. This means a wetter consistency than would be used for plain pipe manufactured by machine. But even for machine-made pipe there should be enough water used in the concrete so that web-like markings will show on the outer surface of the finished product uniformly from end to end when the molds are removed.

Low Cost

Reinforced monolithic concrete on account of its low cost has, for some years, been practically above competition in the construction of large sewers. The same holds true of reinforced concrete pipe in large sizes. In the manufacture of concrete sewer pipe of large size, the use of steel reinforcing proves economical and advantageous.

Requirements of Reinforcing Concrete Pipe

Some of the largest concrete pipe plants have worked out reinforcing requirements. An accompanying illustration shows the general scheme of reinforcing and providing for coupling sections of pipe, as practiced by one of the well-known manufacturers of concrete sewer pipe, while the table which follows

shows the style of reinforcing, shell, thickness, number of couplers and size of bars used for that purpose in pipe ranging from 15 to 48 inches in diameter.

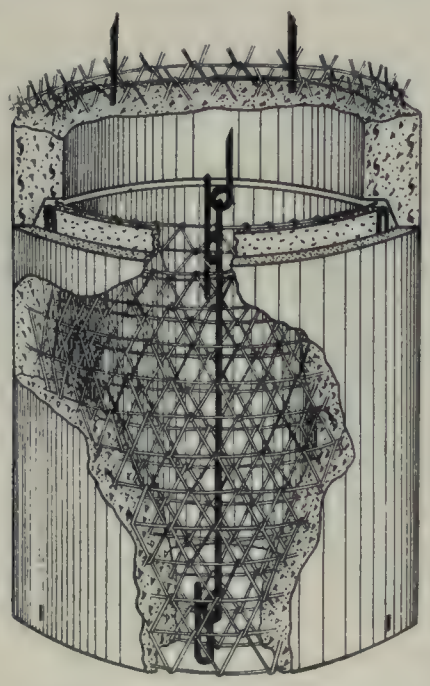
Inside Diameter	Style Wire	Shell	Couplers		Size Bars
15	6	2¼"	3	3/8"	round rods
18	5	2½"	3	3/8"	round rods
24	4	3"	4	5/16"	square twisted rods
30	42	3½"	4	5/16"	square twisted rods
36	23	4"	4	3/8"	square twisted rods
42	23	4½"	4	3/8"	square twisted rods
48	23	5"	5	3/8"	square twisted rods

To ensure a good product, careful specifications regarding the manufacture of concrete pipes are necessary. As a guide, in the following paragraphs are reprinted from a recent pamphlet of the Portland Cement Association, their recommendations which, if followed, will provide a uniformly high quality product.

Recommendations to be Followed in the Manufacture of Concrete Sewer Pipe by Machine

I. Materials

1. Portland Cement. The cement shall meet the requirements of the Standard Specifications for Portland cement of the American Society for Testing Materials.



A method of reinforcing concrete sewer pipes.

2. Fine Aggregate. Fine aggregate shall consist of sand, crushed stone or gravel screenings, graded from fine to coarse, and passing when dry a screen having four meshes per linear inch, and shall preferably be of siliceous material, clean, coarse, free from dust, soft particles, loam, vegetable, or other similar foreign matter. Not more than 20 per cent. shall pass a sieve having 50 meshes per linear inch and not more than 6 per cent. shall pass a sieve having 100 meshes per linear inch. The fine aggregate shall be of such quality that mortar composed of 1 part Portland cement and 3 parts fine aggregate by weight, when made into briquets will show a tensile strength equal to or greater than the strength of 1 to 3 mortar of the same consistency made with the same cement and standard Ottawa sand. In no case shall fine aggregate containing frost or lumps of frozen material be used; neither should fine aggregate containing more than 3 per cent. by weight of clay, loam, or other organic or soluble matter, as determined by washing, be used.

3. Coarse Aggregate. Coarse aggregate shall consist of inert material, as pebbles or crushed stone, graded in size, retained on a screen having four meshes per linear inch. It shall be clean, hard and durable, free from dust, vegetable or other foreign matter, and shall contain no soft, flat or elongated particles. In no case shall coarse aggregate containing frost, or lumps of frozen material, be used, The maximum size of coarse aggregate shall be no greater than one-half the wall thickness of the pipe, and in no case should the coarse aggregate exceed 1 inch, although a maximum of ½ inch is preferable.

4. Natural Mixed Fine and Coarse Aggregate. Natural mixed aggregates shall not be used as they are received from the deposit. They shall be screened over a ¼ inch screen and mixed to agree with proportions specified.

II. Workmanship

5. Measuring Materials. A sack of Portland cement (94 lbs. net.) shall be considered 1 cubic foot. The method of measuring the various materials for the concrete shall be one which will insure separate and uniform proportions of each of the materials at all times. When cement in bulk is used, the cement shall be accurately measured in such a manner as to insure that the quantity of cement used as the equivalent of one sack in the proportions specified below, shall be 94 pounds.

6. Mixing. The concrete materials shall be mixed to the desired consistency in a batch mixer of approved type. The mixing shall continue for at least two minutes after all materials, including water, are in the mixer.

7. Retempering. Retempering of mortar or concrete which has partly hardened, that is, remixing with additional materials or with water, shall not be permitted.

8. Proportions to be used. For the manufacture of concrete pipe up to and including those of 12-in. internal diameter, concrete shall be mixed in the proportions of 1 sack of cement to not more than 2½ cubic feet of fine aggregate. For the manufacture of pipe above 12 inches internal diameter, concrete shall be mixed in the proportions of 1 sack of Portland cement to not more than 4 cubic feet of fine and coarse aggregate measured separately. In no case shall the mixer contain more than 2½ cubic feet of fine aggregate to each sack of cement.

9. Consistency. Concrete shall be mixed as wet as can be used and at the same time permit the immediate removal of the outer casing or form from the pipe. As an indication of the required consistency, the pipe should show on the outer surface web-like markings, or watermarks, indicating free moisture after the removal of the jackets. Interior surfaces of the pipe should show trowel marks caused by free water coming to the surface under the troweling action of the revolving packer head or core, in case such is used.

10. Forming. Pipe shall be made in such a manner as to insure a dense and uniformly compacted product with smooth ends and inner surfaces. Each pipe shall be of a cylindrical section, the size being designated by the interior diameter. The thickness of the pipe should be practically uniform throughout and be not

less than one-tenth of the diameter, with a minimum thickness of three-quarters of an inch. The diameter shall not vary more than three per cent. from that specified.

11. Precautions. No pipe shall be made when the temperature of the atmosphere surrounding the machine is lower than 50 degrees Fahrenheit. Aggregates and water shall be heated when the temperature of either is lower than 50 degrees Fahrenheit.

III. Hardening

12. Steam Hardening. Within sixty minutes after removing the outer casings from the pipe they shall be placed in a hardening room, where the temperature is not lower than 50 degrees Fahrenheit, and be protected from drafts of air, or other influences which would tend to cause evaporation of moisture from the concrete. Within twelve hours after removing the pipe from the machine the temperature in the hardening room shall be raised to at least 100 degrees Fahrenheit, and an atmosphere saturated with water vapor shall be maintained by introducing water vapor into the room from a steam boiler, or through a perforated pipe laid perforations down, in a trough of water on the floor of the hardening room.

(a) During a certain season of the year when the outside temperature during the day does not fall below 50 degrees Fahrenheit, the pipe shall be steam hardened as described above for not less than forty-eight hours, after which they may be removed from the hardening room and piled out of doors. They shall, however, then be sprinkled not fewer than three times daily for seven days. They may be shipped after having been stored out of doors not fewer than fourteen days.

(b) When the temperature of the outside atmosphere falls below 50 degrees Fahrenheit during the day, the pipe shall be steam hardened for not fewer than 96 hours, after which they may be piled out of doors. They then require no further treatment, but shall remain in storage for not fewer than fourteen days before shipment.

13. Water Hardening. It is sometimes found impracticable to introduce steam into the hardening room. The pipe should, however, be handled in the same manner as previously described under steam hardening until they have become sufficiently hard so that when water is sprayed upon them they are not injured. The pipe shall then be kept constantly wet on the surface by sprinkling with water for not fewer than seven days for case (a) and fourteen days for case (b), and the temperature shall be maintained at not less than 70 degrees Fahrenheit in the hardening room. After removing from this room, the pipe shall be treated as described above for steam hardening, except that the period of storage out of doors shall not be fewer than fourteen days.

14. Steam and Water Hardening. It is sometimes desirable or advantageous to use a combination of the steam and water hardening processes as outlined above. The pipe in this case shall be hardened in the steam room under conditions already described for steam hardening until such time as they are sufficiently hard to permit being piled one upon the other. They may then be removed to a chamber where sprinkling can be done and where they will at all times be protected from drafts of air. Under this system of treatment they should be kept constantly wet on the surface by sprinkling for a period of not fewer than two days for case (a) and not fewer than seven days for case (b). The temperature in this chamber shall not be allowed to go below 70 degrees Fahrenheit for the period mentioned. After the pipe are removed from the sprinkling chamber they shall be further hardened in the manner described above for steam hardening, with the exception that the period of storage out of doors shall in no case be less than twenty-one days.

IV. Handmade Concrete Pipe

Sewer pipe of large size, especially those above 24 inches in diameter, are usually manufactured by hand—often at the site of the work. The forms usually consist of properly shaped steel plates with the inner form so placed within the outer one that the shell of the finished pipe will be of the desired or required thickness. The forms are kept clean and free from rust by removing any particles of adhering concrete each time after use and by wiping the forms with oil-soaked waste, particularly just before again using them. Depending upon the size of pipe to be manufactured, both inner and outer forms are constructed of two or more pieces properly stiffened, and fitted with necessary fastening and clamping devices. Usually inner and outer forms are so arranged that the inner form when set up with the outer one becomes self-centering.

In the manufacture of concrete pipe by hand a somewhat arbitrary rule has been more or less recognized with reference to the thickness of the shell of such pipe. Some manufacturers base thickness of the shell on a factor which corresponds to one-twelfth of the diameter of the pipe in inches. Other manufacturers use a factor of one-tenth, while there are times when specifications recognize both of these factors, depending on the size of the pipe. No doubt under certain conditions a factor of one-twelfth gives ample strength and thickness, but if the service conditions to be met with are severe, a shell thickness equal to one-tenth of the diameter of the pipe is preferable.

The concrete mixture to be used in the manufacture of pipe by hand should never be leaner than 1 sack of Portland cement to 2 cubic feet of sand, to 4 cubic feet of pebbles or crushed stone, with sufficient water to produce a quaky consistency, care being taken not to use so much water as to cause coarse aggregate and sand-cement mortar to separate. All materials should meet the requirements for cleanness, grading, etc., as already given in the recommendations covering the manufacture of pipe by machine.

In order that the concrete mixture may be properly handled in the manufacture of reinforced concrete pipe by hand, coarse aggregate (pebbles or broken stone) should not exceed ¾ inch in greatest dimension for pipe with shells 4½ inches and less in thickness. Where shell thickness is greater than 4½ inches, coarse aggregate up to 1½ inches may be used, but owing to the position of reinforcement and the method by which some types of joints are formed, a maximum of 1 inch for coarse aggregate will be found preferable.

Machine mixing is preferable to hand mixing since by machine greater uniformity of mixing is certain. All of the materials for each batch of concrete should be kept in the mixer for at least two minutes.

In filling forms, the concrete should be deposited in layers around the entire section between inner and outer forms, and be well spaded while placing to insure thorough bond with or adhesion to reinforcing metal, and also to insure that the concrete will be settled to maximum density and that coarse particles

will be forced back from form faces, thus increasing the density, hence watertightness of the pipe.

Climatic conditions, as well as the season of the year, make it impossible to arbitrarily fix the length of time which forms should be left in place on hand-made concrete pipe. The same conditions make it impossible to state how long such pipe shall be allowed to harden, or age, before they may be placed in the trench. The same general precautions to prevent drying out of the concrete, that have previously been mentioned as necessary to the proper hardening of machine-made pipe, apply equally to hand-made concrete pipe. If they are hardened by the water process, they should be kept moist for a period of at least seven days after forms have been removed. Proper hardening is very important to securing a high-grade product, and has great influence on the ultimate success of or dissatisfaction with the pipe.

V. General Remarks

In the manufacture of pipe by the ordinary processes, using machines equipped with a revolving packer head, or with tampers and revolving core to form the shell, it will be found practicable to use aggregate having a maximum size of particles of ¼ inch for all sizes up to 12 inches. In sizes larger than 12 inches it will be found practicable to use aggregate having a maximum size of ½ inch or larger, depending upon the thickness of the pipe wall, but in general a maximum of ½ inch is preferable.

A deficiency in fine material in the aggregate causes difficulty in the manufacturing process, loss of pipe when removed from the casing, rough surfaces, stone pockets, and pinholes through which water may be forced when the pipe is subjected to internal water pressure. A deficiency of fine material within certain limits does not decrease the strength of the finished product. Excess of fine material causes low strength in the finished pipe, and with ordinary mixtures tends to produce a pipe which will show seepage under internal pressure. There is a marked tendency to use an excess of fine material in the aggregate, and this should be particularly guarded against. Unless pipe are tested, the manufacturer may be deceived as to the quality of the product which he is making, owing to the smooth and (to the uninitiated) workmanlike appearance of the pipe in which aggregate containing an excess of fine material has been used.

There are two indications of good quality in pipe:

(1) High supporting strength.

(2) Low percentage of absorption.

Pipe showing a small percentage of absorption are in every respect preferable to those in which the percentage of absorption is high. In investigating and determining the absorption it is necessary to dry the pipe at a temperature of 212 degrees Fahrenheit until they show no further loss in weight. Pipe will absorb their full capacity of water within twenty-four hours after immersion. Tests have clearly shown that high strength and low absorption go hand in hand.

The quantity of water to be used in each batch of concrete is something upon which the uniformity of the product more or less depends. It is recommended, therefore, that an automatic measuring device be utilized, permitting the proper quantity of water to be used in each batch, this quantity being determined after a batch of the proper consistency has been made. A similar quantity should be used in each batch until working conditions demand a change.

In connection with the steam hardening process, two requirements deserve particular emphasis, because if neglected, they sometimes cause improper hardening of the pipe.

(1) The steam hardening room must be sufficiently tight to prevent circulation of air and the consequent existence of a heated atmosphere not thoroughly saturated with water vapor, which would result in evaporation of water from the pipe walls.

(2) In no case should steam be allowed to enter the hardening chamber under pressure in such a manner as to strike directly upon the green pipe. The effect of this is to heat them quickly, causing evaporation of water from the interior of the pipe and the destruction of the product. In the manufacture of high standard and uniform concrete pipe, proper hardening is absolutely essential.

Test Requirements

Specifications usually require that concrete pipe shall meet certain test requirements. Such tests are made to determine the crushing strength of the pipe, their impermeability, and their resistance to internal pressure which would tend to burst them. All tests which have been made on properly constructed concrete pipe when compared with similar tests of pipe made of other materials, have demonstrated the superior quality of concrete pipe and show that they possess strength far in excess of that necessary to meet the conditions under which generally used.

Considering the fact that the greater portion of concrete pipe sewers now in existence in this country and elsewhere have given long years of satisfactory service, often in spite of the fact that the methods by which pipe were manufactured in the past do not approach present-day high standards, it is reasonable to assume that the very superior product of today will meet every requirement exacted from it in sewer work. The same holds true of concrete in monolithic sewer construction.

Such isolated cases as have been brought to notice of the disintegration of concrete when subjected to sewage have invariably been traced to poor materials or methods of workmanship. If the methods outlined in the recommendations previously given are followed to the letter, concrete sewer pipe may be relied upon to meet the most exacting conditions imposed upon them in modern sewer practice.

Monolithic Concrete Sewers

When concrete is used for sewer work in the form of monolithic construction, it is, of course, necessary that specifications shall be prepared for the work, with particular reference to the conditions that are to be met on each individual job. Owing, therefore, to the differences in designs which will naturally be adopted to best meet local conditions, it is impossible to present an invariable specification for monolithic concrete sewer work.

A 1:2:4 concrete is to be recommended for all reinforced sections in monolithic sewer construction. A leaner mixture may be and usually is used for any necessary mass work such as foundations. Cement, sand, and pebbles or crushed stone used in monolithic concrete sewers are subject to the same general specification requirements that govern in all other first-class concrete work. Concrete should be mixed in an approved machine of the batch type. Accurate measuring devices should be used for proportioning the mixtures so that each batch will be uniform. No concrete should be used after hardening has started and no remixed, or retempered concrete should be

(Concluded on page 885)

Handsome Churches of Quebec Province

WORK is now proceeding on a Roman Catholic cathedral for the diocese of Sherbrooke, from plans prepared by Messrs. Audet & Charbonneau, architects, Montreal and Sherbrooke, P.Q. At present it is intended to build on a section of the cathedral, leaving to a later date the rest of the construction. A bishop's palace, connected with the cathedral, will also be built later.

The site, which is on a commanding height, is of a sloping nature at the back of the building, which rests on solid rock. To provide for a lower church, under the cathedral proper, 75,000 cubic yards of stone had to be excavated for the building and surrounding area.

Half of the floor of the lower church is underground and the other half built over a large crypt, which contains a mortuary chapel for the burial of the bishop, and also a hall, choir practice room, janitor's quarters, and ventilating apparatus. The heating apparatus is placed outside the building.

The outside dimensions of the cathedral are roughly 265 feet long by 150 feet wide in the transepts. The width of the nave inside is about 43 feet. The nave is flanked by two aisles, and separated from the chancel by a large transept, which contains a chapel; on the side of each aisle there are also small chapels.

The church is to be substantially built, with heavy stone walls and buttresses, the entire work being carried out in a style reminiscent of the early Gothic of Normany. The exterior is of white Megantic granite. The plain portions of the walls are to be left with the rock face, the trimming only being cut to a smooth surface.

One of the features of the lower church is the large tile vault, on the Guastavino system, which has a span of 45 feet and 5 feet 9 inches of rise. This vault, which is comparatively light, will also support the floor of the church proper. Heavy pillars receive the vault, and will carry the columns and vault and roof of the upper church. On each side of the church there are large sacristies, separated from the church by a passage.

The west front, as planned, will have two towers, modelled on the same plan as Notre Dame de Paris. Three porches are pierced in the wall of this front. Over these will be a row of niches, which are to be filled with statues, while in the centre, above the niches, a large rose window will be built. Similar windows are to be constructed in front of each transept.

The bishop's palace is to be situated at the south side of the cathedral, and will be connected with the church by a cloister, while connection with the lower church will also be provided.

Church of St. Jacques de l'Achigan

The Church of St. Jacques de l'Achigan, now in course of erection, is the outcome of the destruction by fire of the ancient parish church two years ago. As a result of this, it was decided to build the handsome edifice at present under way, of which the exterior is illustrated herewith.

The total width across the front is 83 ft. and the length 220 ft. The height from the floor to the centre of the vault is 57 ft., and the two clochers measure 190 ft. from the ground to the top of the cross. The ground floor has accommodation for 1,218 persons, exclusive of 200 in the choir stalls and 375 in the organ and transept galleries.

Steel construction is employed throughout, with an exterior facing of rough free-stone and trimmings of dressed stone from the Deschambault quarries. A spacious narthex or vestibule with three entrances gives access to the interior, which includes the nave, transepts, and semi-circular sanctuary and sacristies. There are also two entrances to the transepts. The whole interior is very ornately decorated, the nave having a barrel-vaulted ceiling with decorated ribs and panels, and the arcade columns and cornice are richly ornamented in the Corinthian style.

The lighting will be by electricity and the heating

Front View - Roman Catholic Cathedral, Sherbrooke, P. Q.

Church of St. Jacques de l'Achigan.

by hot water from the Sirdar hot water boilers located in a sub-basement.

The architect is Mr. L. J. Caron, of Nicolet, Que. The general contractor is Mr. Joseph Giroux, of St. Casimer, P.Q., and the steel work is being supplied and erected by the Phoenix Bridge Company, Montreal. The contract price amounts to $175,000. The structure will be completed by next May.

District of West Vancouver Waterworks—Distribution by Wooden Pipe

During the past few years the district of West Vancouver, on the north shore of Burrard Inlet, west of the harbor entrance, has gained a large increase of population owing to improved transportation facilities and the discovery made by Vancouver's wealthy citizens that the district offered ideal advantages for summer homes. With population came a demand for a waterworks system, but just then the war disarranged finances, and the corporation found it impossible to market its bonds. For a time it looked as if the residents would have to await better times, but, luckily, the Cotton Company, Ltd., Vancouver, who had been awarded the contract, were able to take payment in bonds, and the work went ahead with all possible speed, being completed a couple of months ago to a point that permitted the turning on of house services.

Bonds to the amount of $150,000 were issued, the cost of the system being $117,000 in bonds. The territory served has a population of about 2,500, the number of services applied for and installed at the outset being 250. The watered area is five square miles, the source of supply being Brothers Creek, elevation 724 ft. above sea level, and fed from Capilano River watershed. The creek has a minimum flow of 3 cu. ft. per second, maximum 40 cu. ft. per second, and average 5 cu. ft. per second. The intake consists of a small concrete dam.

The distribution system is as follows: 1,531 ft. of 10 in. wire-wound wood pipe, head 50 ft.-125 ft.; 5,638 ft. 8 in., 50 ft.-275 ft.; 58,220 ft. 6 in., 50 ft.-375 ft.; 37,453 ft. 4 in., 75 ft.-370 ft.; 1,611 ft. ¾ in. galv. service pipe; 8,632 ft. ½ in. galv. service pipe.

There is a float box at an elevation of 350 ft., controlled by 6 in. Ford balanced float valve.

The working pressures on service pipe range from 40 pounds to 135 pounds.

Unit field cost of construction: Trench (16 in. x 36 in.), per lin. ft. .071, per cu. yard .507; back fill (16 in. x 36 in), per lin. ft. .01, per cu. yard .071; heavy clearing (6 ft. wide), per lin. ft. .072; laying wood pipe, per lin. ft. .015; service trench (12 in. x 18 in.), per lin. ft. .02½; 10-in. wood pipe, .35; 8-in. wood pipe, .32; 6-in. wood pipe, .26; 4-in. wood pipe, .18.

The contract was carried out by W. H. Larson, superintendent in charge for the contractors; W. Curror, municipal engineer of District of West Vancouver, was in charge for the municipality.

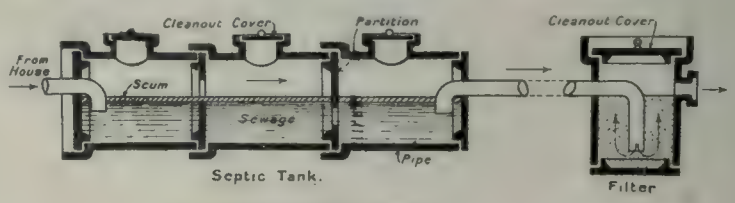
The contract for wood pipe, aggregating over 20 miles, was filled by the Canadian Pipe Company, Ltd., 550 Pacific Street, Vancouver.

Small Septic Tanks Built of Vitrified Clay Pipe

For country residences, public institutions, and small communities in the United States the sewage disposal is in many cases being provided for by small septic tanks built up of vitrified clay pipe sections. The pipes are 24 in. interior diameter and 30 in. long, with a clean-out hole and cover on top. They are laid horizontally, and fitted with heads and baffle diaphragms or partitions of the same material. The number of sections varies according to the capacity required, and may be increased as needed to keep pace with the growth of the institution or village. The largest installation at present is that at the State Tuberculosis Hospital, in Texas, where the tank consists of 60 pipes or sections.

This system is briefly described in a current issue of The Engineer. From the end of the septic tank a 4-in. pipe leads to a filter. This is similar to the tank pipes, but is set on end, and closed with vitrified clay covers at top and bottom. This is filled to the flow line with sand and gravel, or with charcoal. The effluent pipe is turned down vertically, and extends nearly to the bottom of the filter. The liquid rises through the filtering medium and escapes at an outlet opposite to the pipe from the septic tank.

One filter section is sufficient for three or four tank sections. The filter is used only when the effluent is



Small Sewage Disposal Plant.

to be discharged into a stream or pond. In many cases, however, the effluent is utilized in a sub-irrigation or farm drainage system, laid out with 4-in. tile. In such cases the filter is omitted, and the effluent pipe from the septic tank is connected directly to the head of the tiling.

The Ransome Drifting Sand Filter

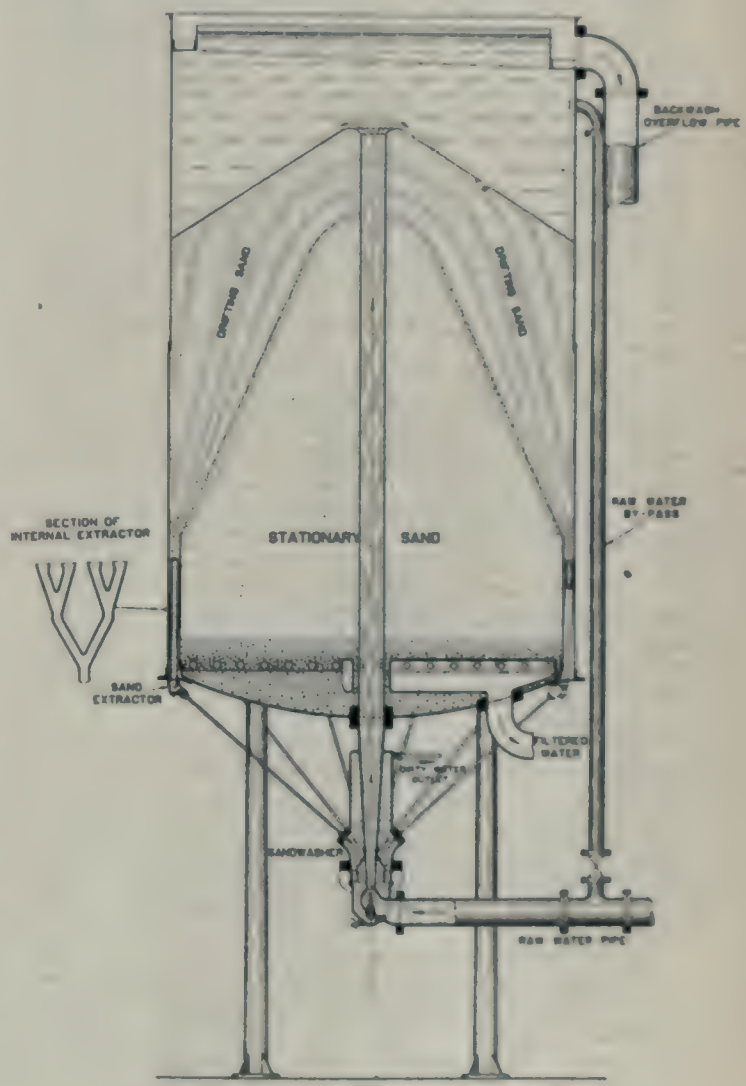
Description of the Design and Operation of the New Mechanical Filters Just Installed for Toronto

As a result of the article which appeared in the Contract Record dated August 16, 1916, describing some of the construction features of the mechanical filtration plant now almost completed for the city of Toronto, we have received several requests for a short article describing the leading principles involved in this Ransome drifting sand system of water purification.

The illustration shows a typical section through the axis of a single unit gravity filter, and the essential features of the system are indicated. Very few changes are necessary to make the filter of a pressure type. The filter, which in the illustration is of steel, may, however, be made of concrete or other building material. The total depth required is much deeper than in the usual form of mechanical filter, and the filter is filled with sand to a depth of 9 feet, which is about three times the ordinary depth. The filter sand consists of two portions of precisely the same materials, with no physical boundary between them other than that produced by causing the upper portion (which forms a cap over the lower portion) to slowly and almost imperceptibly creep or drift over the lower portion and across the paths of the filtering water, which takes place more or less downwards and inwards.

The filtered water is collected at the bottom of the sand by a system of pipes, with equally spaced perforations in them, and buried to a depth of nine inches in graded spherical or rounded water-worn graded gravel, the largest size being 20 mm. and the least 3 mm. The spaced holes serve the purpose of uniformly distributing the back wash water for cleansing the whole of the sand in the filter, which would otherwise burst up in local springs, leaving parts choked and unwashed. The sand has a maximum size of 1.2 mm. (60 per cent. is less than 0.7 mm. and 10 per cent. less than 0.35 mm.), and is of rounded water-worn hard materials. Around the periphery of the filter is a passage or system of ports, down which the drifting sand passes.

The raw water, which has already been coagulated, enters the filter, partly by a standpipe at the centre of the unit, passing up through a separator or sandwasher at the bottom and delivering above the sand at the top and partly through a bye-pass. Within the sandwasher the raw water pipe is provided with a fair form restriction in every way similar to the tube of a Venturi meter, and the drifting sand collected in the separator is inducted into the raw water at the narrowest part of the restriction, and this sand passes up the standpipe with the water and is delivered with it above the top of the sand already there, forming a volcano-like cone, which continuously drifts away and is continuously being replaced, leaving a round-topped body of stationary sand resting upon the filtered water collecting system. This sand does the final filtration. The surface area of this stationary sand is more than twice the plan area of the unit, and economizes the plan area of the filters. The drifting sand passes down all round the boundary of the stationary sand to a slot at an elevation of 2 ft. 2 in. above the surface of the underdrain gravel, and ultimately passes through converging ports to a system of outlets or extractors and pipes to the sandwasher, in which the sand falls to the bottom through a current of raw water and is picked up by the inductor, the dirty water passing upwards and out at the top by an outlet suitably controlled. The sand extractors are of such a form that the sand for a short distance is made to move vertically against gravity, and experience shows that it is kept out of the piping system, except when the inductor at



RANSOME DRIFTING SAND FILTER
GRAVITY TYPE

the sandwasher is in full operation. That is to say, the sand moves only when there is an abundance of running water, which carries it forward.

The question of sand scour is an important one, and the form of the inductor is such that the sand enters the high velocity water at the throat of the sand washer at the centre of the stream and can only touch the sides of the pipe at a high level, where the pipe is much enlarged, and not until after the sand and water has been reduced to non-scouring velocities. The loss of head at the inductor amounts to about 3 ft. 6 in. of water, but a bye-pass is provided so that this may be varied either at will or automatically in such

a way that the induction may be varied to suit the amount of the impurities and of the coagulants in the water, it being understood that the greater the proportion of the total raw water passing through the inductor the greater will be the rate of drifting of the sand. If the sand drifts too slowly, then the bed will choke up and the loss of head will go up and ultimately put the filter prematurely out of business. On the other hand, by drifting the sand too fast, unnecessary labor is put upon the apparatus, and a larger proportion of the dirty coagulant penetrates right through the drifting sand to the stationary sand underneath. Provision is made for adjusting the proper rate of drift by bye-passing an adjustable amount of the raw water direct to the filter instead of passing it through the sand-washer. To a sufficient extent the rate of drift is automatically varied with the amount of water being filtered, but in the case of the more turbid waters a high proportion is sent through the sandwasher. In the case of comparatively clear waters, however, a large proportion is sent through the bye-pass.

From the description it will be seen that the raw water, after coagulation, has a continuous proportion of drifting sand added to it. This sand settles down in the filter on the top of the drifting sand, and the water then passes through this drifting sand, which removes the bulk of the impurities in it, and finally passes into the stationary sand, which completes the process.

The drifting of the sand is so effective that Toronto's crude sewage and water containing clay turbidities running into thousands of parts per million have been successfully treated at normal rates. So effectively does this work that these filters will operate from one to four weeks without backwashing, whereas the ordinary mechanical filter requires to be backwashed about once per day. Backwashing is carried out by means of sterilized filtered water at sufficient pressure to completely stir up every part of the sand bed. This is accomplished by reversing the flow through the collecting system when the loss of head becomes so high that the normal rate of filtration cannot be obtained.

When it becomes advisable to adopt large filters a number of units, as described and shown in the illustration, are grouped together in a single container. The separate units then, instead of being circular in plan, become segmental, and these are carried up only to the level of the drifting sand slots. That is to say, to an elevation of 2 ft. 2 in. above the level of the underdrain gravel.

In the filters erected for the city of Toronto there are 30 units in each filter or container, arranged in two rings of 18 and 12 respectively, leaving a central space in which a bye-pass controller and a float regulator are placed. The grouping of the units together makes a considerable saving in the cost of materials of construction and also in the control and management.

From the above one can readily see that many new phases of water purification are opened up, and that everything points to many of the difficulties of operation encountered in the ordinary mechanical filter being eliminated. Without going into detail, the following advantages appear to be fulfilled by this filter:

1. The effective filtering surface is that of a cone-shaped body, whose area is from 2 to 2½ times the horizontal area of the filter.

2. The elasticity of operation is such that almost instantly changes can be made in the operation by change in the rate of the drifting sand. In this way sudden changes of turbidity can be easily controlled.

3. The effective length of run is greatly increased over that of an ordinary mechanical filter. This gives a greater average output per filter in comparison with the rated output.

4. Coagulating or sedimentation basins are entirely eliminated. In a sense, the drifting sand takes the place of any settling-out period, for, after all, sedimentation basins are installed for the purpose of throwing less work on the filter, thus increasing the time of the length of run.

While this system of water purification is comparatively new, it has already proved satisfactory in every way where it has been installed. Great interest is being shown in the results obtained, and the engineering profession are looking forward with keen interest to the results from the 60,000,000 Imperial gallon plant erected for the city of Toronto.

Eighteenth Annual Convention of the Ontario Municipal Association, in Toronto

The Ontario Municipal Association held its eighteenth annual meeting at the city hall, Toronto, last week. At this convention, representatives of municipalities in Ontario discussed matters of importance in municipal government and adopted a number of beneficial resolutions covering, for example, contentions that business and income should be taxed the same year as the assessment is made; that the Ontario Legislature should take into consideration the proposition to take over the private telephone lines and reorganize them into county systems; that a municipal department be organized at the Ontario Legistature; that legislation be passed compelling able parents to support their offspring and vice versa. The president of the association, Mr. A. K. Bunnell, city treasurer of Brantford, urged municipal councils to pay more attention to the big problems of municipal government and not take up their time with trivialities. He spoke of Canada's part in the war crisis and prophesied greater responsibilities and duties on the part of civic authorities as the termination of the war drew nearer.

Several excellent addresses and papers were delivered at the various sessions. Mr. J. B. Laidlaw, manager of the Norwich Union Fire Insurance Company, stated that the fire loss approximated $22,500,000 per annum and the loss of life so far this year totals 360. His address was a plea for greater study of preventive measures and for standardized fire-fighting apparatus. Mr. W. K. McNaught, C.M.G., spoke on Hydro development, with special reference to export of power, the Chippewa scheme and electric radials. "Proposed Town Planning Legislation" was the subject of Mr. Thos. Adams' address, in which he pointed out the advantages and necessity of this important development. Dr. C. J. Hastings, M.O.H. of Toronto, discussed the duties of municipal councils in maintaining public health. The methods of disposing of domestic wastes were described by F. A. Dallyn, Provincial Sanitary Engineer, and Major J. S. McCullough read a paper on "Water supplies in towns and cities."

The report of the Nominating Committee was adopted as follows:—President, Mr. W. C. Caughell, Township Clerk, Yarmouth; the vice-presidents, in their order, Ald. E. H. Menzies, Niagara Falls; Mr. A. M. Chapman, County Clerk, Belleville; Mr. A. Ferland, Reeve of Coleman; Mr. S. H. Kent, City Clerk, Hamilton; Mr. S. Baker, City Clerk, London. Mr. F. S. Spence was re-elected Secretary-Treasurer.

Two Years of Britain at War

The First Year Meant Organization—the Second Preparation — the Third Finds Us Equipped and Confident

To-day (August 4, 1916) is the second anniversary of our entrance on the theatre of war. During the last twenty-four months the whole world has been passing through such a period of stress as has never before been experienced. It may perhaps be useful to glance at the way in which we have met the cataclysm and how we have borne ourselves in the world-wide struggle. In August, 1914, our navy, though by no means as strong as it would have been but for years of wilful opposition to its growth, was yet strong and well equipped. Our army, such as it was, was ready to the last button to take the field, and in a surprisingly short time an expeditionary force, which under other circumstances would have been considered large, was despatched, complete in every detail, to France and Belgium. The whole world knows the wonderful part played by that comparatively puny force—that "contemptible little army"—in the general scheme of operations of the allies. Had we but had to keep that army up to strength , or at the most to increase it slightly, the history of the past two years would have been very different to what it has been. But it was realized from the very first that more — very much more — would have to be done. It was impossible to meet millions of men with tens of thousands, or thousands of guns with hundreds. So the new armies were called into existence and the problem arose of how properly to equip them with accoutrements and war material in the shortest space of time. Exactly in what manner that problem has been solved we are not at liberty to speak, but we venture to predict that when the time comes for all to be told, the disclosures will be astounding in their magnitude. For the first year and more of the war we were unquestionably outclassed by the enemy in every respect—in numbers of men, in quantity and quality of artillery and machine guns, and in supplies of munitions of every description. That we were not overwhelmed at the outset and at several later periods is due solely to the magnificence of the human material which we were enabled to put into the field. Even the partially trained Territorial troops, which were hurried across the Channel to fill the gaps made in the original expeditionary force, early proved themselves to be possessed of sterling military qualities, and to be at least equal, and in many cases much more than equal, man for man, to the foes they had to face. Of the new armies and of the troops which have flocked to aid the Mother Country from overseas dominions and dependencies it would be impossible to speak too highly; nor is this the place in which to do it. Yet, while we yield to no one in our admiration for the valor, the heroism, and the self-sacrifices of all our troops of whatever origin who have been engaged in the great struggle, we have to admit that all of these magnificent attributes would have been displayed in vain had it not been that each month has seen increasing volumes of munitions of war made available for service. We have had to supply guns, ammunition, and every sort and kind of war paraphernalia not only to our own rapidly increasing armies, but to our allies as well.

And so we enter upon the third year of the war, and the question naturally arises, How do we stand as compared with our position two years ago? The answer is that we and our allies are immeasurably better off than we were either at the beginning of August, 1914, or at any time since the war began. It is true that there have been numerous vicissitudes—the overrunning of Poland, Serbia, and Montenegro, the failure of the enterprise on the Gallipoli Peninsula, and the surrender of the garrison of Kut. But what is there to counterbalance these set-backs? Germany has lost all save one of her colonies. The last is being wrested from her by slow and sure degrees, Belgium and Portugal assisting in the process. Russia is making great strides, not only in Armenia, out of which all Turks are now said to have been cleared, but on her western front as well, on which during the present offensive she has taken, according to all accounts, some 350,000 prisoners, in addition to valuable war materials and stores. France has withstood well-nigh six months' continuous assault before Verdun with a bravery and stubbornness which have evoked the admiration of all, and has defied the weighty onset of the heaviest artillery which the enemy could bring against her. Moreover she has made good progress on the Somme, and, side by side with her we, too, have pressed forward. Throughout the remainder of the line the enemy, where he has not been driven back, has been held firmly in check, and will be so held until the time is ripe to dislodge him. Italy, gallantly recovering from a fierce attack, is once more driving the Austrians backwards. The Serbian army, refreshed and rehabilitated, is again at grips with Bulgaria. The greatest sea fight of history has been fought, with the result that, though we lost some ships, the Germans lost more, and had to fly back to their bases under cover of darkness in order to avoid complete annihilation. The "victory" which was acclaimed with joy throughout the Central Empires was, as a fact, a defeat, which only the failure of the light saved from being an overwhelming disaster, and which rendered Germany even less powerful as a naval force than she was before. We still hold the seas, and the iron grip of the blockade becomes tighter and tighter. It is more and more difficult for our adversaries to obtain the wherewithal to make their munitions and to feed their peoples. Finally, the losses they have sustained are so colossal that the task of reinforcing their depleted fighting lines is giving them the greatest anxiety.

In discussing the condition of affairs this time last year, on the completion of twelve months' fighting, we said that we could look back without shame on what we had done during that year. We can now look back with pride on what has been done since then. It took the masses of our people some time to realize the magnitude of the undertaking on which, by no wish of our own, we had been forced to embark. But when once they were awakened to the gravity of the situation all ranks united in a concerted effort, the strenuousness of which has never been relaxed. It was seen that in order to win the fight we must have more men and more war material than were possessed by the enemy, and with that object in view the whole nation set to work. A vast army enlisted voluntarily. The power to enrol more men was obtained by a modified form of conscription. But mere numbers, however

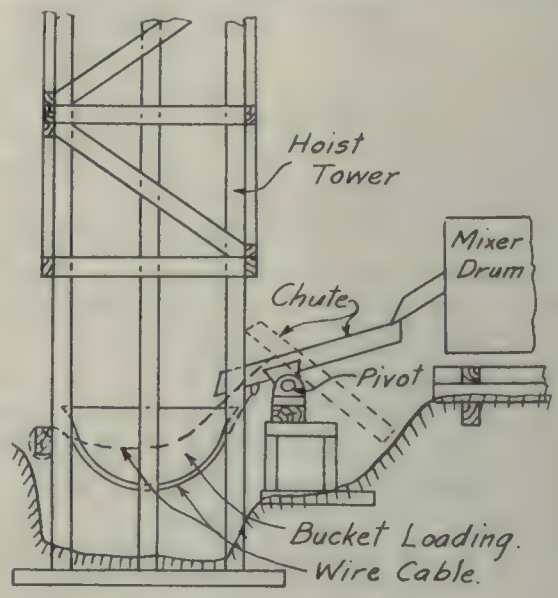
* From the Engineer, London, Eng.

great, could not win any combat. The fighting men must have the wherewithal to fight. It is true that the early history of the war showed that steadfast men could and did withstand the most deadly battering with heavy guns and high explosives; but they did it at a lamentable cost, and to advance was out of the question. Now all is changed. We and our allies, to judge simply by results, are as well provided with guns and munitions as our enemies, if, indeed, we do not possess them in greater numbers. Moreover, our supplies go on increasing from day to day, and will continue to do so as more and more new factories and extensions of existing factories come into operation. Verily the country owes a deep depth of gratitude to its workers! It is not too much to say that there is hardly an engineering establishment throughout the realm which is not helping in some way or other to increase the output of war material. The whole order of things has been changed. Men who a couple of years ago found it hard to kill time have fought magnificently and shed their blood voluntarily for their country. Gently nurtured women have engaged in the manipulation of heavy machinery and in working under the exacting conditions of factory operations. Truly we are an altered nation. Nor do we stand alone. Of all our allies the same tale is true, and all are united by a grim determination to conquer; all are vastly better prepared at all points than they have ever been, and though it may not yet be fully in sight, there is now not the smallest doubt that, in the end, victory must be ours.

Automatic Chute from Concrete Mixer to Bucket

When a tower is used to hoist concrete from the mixer to its distributing point an intermediate chute is usually necessary between the bucket and the mixer. This chute must extend over the edge of the bucket when the latter is being filled. A disadvantage of this arrangement is that when the bucket is hoisted the chute must be pulled out of the way to give the required clearance. The illustration shows a simple manner in which this can be automatically arranged.

The chute is pivoted a little off centre so that the heavy end will ordinarily cause it to keep clear of the bucket. A wire cable is fastened by one end to the



Automatic Concrete Mixer

to the frame of the tower. As the bucket descends to its loading position, it will bear on the cable and pull the chute into position. When the weight of the bucket is released, the chute will fall back by its own weight and clear.

From data collected from some fifty engineering schools throughout the continent it has been determined that 90.1 per cent. of the graduates of the colleges investigated pursue the occupation for which they were prepared, which means that only one in ten leaves engineering to follow another vocation.

Handsome New Factory of Grant, Holden, Graham, Ltd., Ottawa

The accompanying illustration shows the handsome new factory of the Grant, Holden, Graham, Limited, Ottawa, manufacturer of tents, tarpaulins, lumbermen's and contractors' clothing. During February of this year the building of this company was destroyed by fire, but has been replaced by the larger and more modern factory shown herewith. It is a seven-storey fireproof structure of steel and reinforced concrete, 85 ft. x 100 ft. The first two floors will be devoted to the general offices and warehouse space, and the remaining floors are to be given over to manufacturing. The personnel of the company includes S. S. Holden, general manager; B. W. Graham, sales manager, and A. J. Hendry, warehouse manager.

Letters to the Editor

America First: Canada—?

Editor Contract Record:

In recent times a well-known Vancouver building owner proclaimed from a public platform that it was the duty of all residents of British Columbia to deal with business men and firms established within the province, and this at a time when a very large building named after him was nearing completion, under the supervision of architects whose residence was in the United States, although they had a temporary branch office in Vancouver, a building contractor brought from the same place, and in the construction of which a very large amount of American manufactured material had been used.

Complaints have been continuously made by architects, engineers, contractors, and manufacturers of building materials in the Province of British Columbia that an injustice is being done to them in the way that a very large amount of construction work in this province has been for the last six or seven years, and still continues to be designed and erected by Americans, and of American material, and that these American architects, engineers, and contractors may or may not have branch or temporary offices here, but are in any case non-residents of Canada, and that it is reasonable to assume that the profits they make will be entirely lost to the country.

Such non-residents have no community interests in this country, and, unlike the Americans who permanently reside here, merely invade it as exploiters prepared to close down their branch or temporary offices during periods of depression, pursuing, at a distance, a policy of "watchful waiting" until business revives.

The opening paragraph of this letter cites only one of many instances of the particular kind of glaring inconsistency practised by certain building owners in this province.

Moreover, it is remarkable that this absence of patriotic and public spirit has been more particularly exhibited by many of those individuals, firms, and corporations whose chief purpose and interest in promoting the erection of structures is that either as owners of office buildings, bankers, public service corporations or privileged manufacturers, they may seek the support of and make profit out of the Canadian public; and, while objecting to foreign competition themselves, entirely disregard all moral and business obligations to patronize and support such as may be possible of the various branches of Canadian business endeavor carried on in their midst, and by sections of the public to whom they appeal for patronage and support. For it should be borne in mind, even in the case where American capital is introduced into Canada, that it is done solely with the object that it will, from the resources of the country, return profits to its owners, and surely it is no more than reasonable to require the capitalists exploiting the country for their own benefit that in so doing they should patronize and employ the residents of it.

The Pantages Theatre Company is the latest instance where the public of British Columbia is to be asked to support and give profit to a company whose first move in building their new theatre is to ignore the resident and employ an American architect residing in the United States.

That there is no excuse for this condition of affairs in this instance or any other needs no demonstration, since Canadians in all these branches of work are not one whit less competent than their brethren over the line.

That the American architect or engineer is largely responsible for the introduction of the American builder and material has often been conclusively proved, not only in the West but in the East.

Figures issued by the Builders' Exchange of Ontario show that during the year 1915 plans and specifications were prepared by American architects for work amounting to $2,769,000, and that as the result of this favoring of American architects only $90,000 worth of this work was executed by Canadian builders.

Moreover, during this period plans had been prepared by American architects for buildings to be erected in Canada aggregating $4,545,000 in value.

At the present time the Architectural Institute of British Columbia, Inc., is unable to give complete figures on the lines of the Builders' Exchange of Ontario, but from close observation and knowledge of building conditions for several years past, the Architectural Institute is of opinion that figures would make even a worse showing for British Columbia than Ontario.

In Canada protests of this kind are unfortunately only at the complaint stage, whereas in the United States they have for a long time been in the stage of action, and not only do architects', engineers', and manufacturers' societies very strongly intervene, but the American public will not countenance the exploitation of their country by non-residents.

The absurdity of the situation is obvious, and as the plea of patriotism carries no weight, otherwise the situation would not exist, a remedy ought surely to be found that will prevent such injustice being suffered by residents having community interests and responsibilities in Canada, and which will also foster and extend the knowledge that it is not necessary to look to and depend upon the United States for men of ability and for workmanship of quality, but that Canada has among her own residents men as fully qualified and capable of undertaking and carrying on all the various forms of professional and commercial endeavor as can be found outside her borders.

Signed on behalf of the Council of the Architectural Institute of British Columbia, Inc.

R. MacKay Fripp, President.

Roads and Road Signs

Editor Contract Record:

Notwithstanding the numerous road superintendents' conferences and conventions held in Ontario in the past few years, very little, or nothing, is said regarding the proper marking of dangerous curves, bad hills, or railway crossings. This does not seriously affect horse-driven traffic, because it is usually slow enough to be immune from hazard. On the other hand, motor traffic, which now constitutes perhaps the larger proportion of travel, is upon a danger spot before the driver has the slightest warning, and, in many cases, dexterous manipulation alone has prevented serious accident. The Ontario Motor League have, in recent years, erected a few signs along some of the main thoroughfares, but they are insignificant things, hardly worthy of the name, and situated usually close upon the point of peril. This is not much more useful than telling a man "We told you so!" after the accident has happened.

Is it possible that our road engineers are too an-

tagonistic to motor traffic that they will not recognize the right of protection which is due it? Surely the automobile is doing more to benefit the farmer and the smaller towns than perhaps any other factor. It is a nation-builder, though many municipal authorities regard it as a road-destroyer and entitled to their prejudice.

Were we to have a system of highways such as the "state" roads across the border our smaller municipalities would reap untold benefit through increased transient travel. No one who has ever travelled by motor through the State of New York can deny this statement.

These roads are protected, and protected adequately, by warning signs—always far enough in advance to give the motorist sufficient time to slacken his speed, say, from one hundred to two hundred feet from the danger. Neither are these signs the small, inconspicuous pieces of tin and wood such as we sometimes see (if we have good eyesight) in Ontario. In many cases they rival billboards in size, with white letters two feet high painted on a red background. A typical advance warning is: "A fatal accident recently happened on this curve—slow down." Appropriate warnings are placed at every point where there is the slightest possibility of accident, even on curves which we, in Ontario, would consider harmless. Perhaps that is because the majority of our roads are in such bad shape that they are prohibitive of dangerous speeds.

The speed limit in the State of New York is 30 miles an hour, on excellent roads, compared to 20 miles in Ontario, on highways which consist of a series of "thank you, marms," from beginning to end. Motorists are warned to "Beware of speeding" on roads that are in condition only to break automobile springs and dislocate their spines. Signs of this kind might well be replaced by others reading "Danger—go slow!"

However, there is a striking need for appropriate signs to mark the approach of bad hills and curves, situated sufficient distance away to be of benefit to the motorist. Our railways place "Stop, Look and Listen" signs at their level crossings, but often the motorist comes to the crossing before he is aware of its existence. Then the railway company's warning is useless. In the State of New York all railway crossings are marked at points several hundred feet on either side, which is really the only sensible method. On Long Island, just across the river from New York, some notable protective measures are being adopted by the electric railways. On level crossings the gates are painted black and white, after the fashion of a barber pole. These are distinguishable for a considerable distance, and, in addition, there are portable division posts placed in the centre of the road so that traffic must keep to the right going each way. Signs of caution are also placed on all overhead bridges, so that the "safety first" thought is before the driver constantly. Signs of warning for hills, curves, and intersections also constitute silent sentinels for every driver, and an accident is almost invariably the result of absolute indifference or recklessness. Contrast this with Ontario, where we have hundreds of danger spots where complications are unavoidable through lack of warning. For example, on the main road to Niagara Falls, just outside of Burlington Beach, there is a sharp 90 degree turn unmarked with warning of any kind. Even at the legal speed of 20 miles an hour, a complete right-angle turn of this kind on the main road is dangerous. Motorists who use the little bit of Toronto-Hamilton highway at present constructed see no warning or instruction of any kind, even on its most dangerous curve.

Again, in the matter of road or bridge construction, a driver is upon the work without any realization of its presence. In the States a sign would confront him several hundred feet ahead, warning him that construction work was proceeding and to go slow. This eliminates the danger to workmen and vehicles.

A typical example of Canadian carelessness was brought home to me only a few weeks ago. On the new Hamilton-Toronto concrete road there was, in the course of construction, a culvert over which it was necessary to cross by a timber makeshift. Two men were working, supposedly, on the affair and one of them warned me to go careful because the planks were full of nails. This on a highway which was destined to be the pride of Ontario!

Yours truly,

"One Who Motors."

Interesting Exhibit of Oriental Brick Company

One of the most unique and attractive exhibits at the Canadian National Exhibition this year, and one of particular interest to architects and contractors is that of the Oriental Brick Company, 143 Royce Avenue, Toronto, successors to the Faced Brick and Machinery Company, manufacturers of fancy faced brick. The exhibit includes a large model of an old English residence, a true copy of the noted Sir Roger Tichborne's house, Crittenden Manor, Surrey, England, of the Tudor period type, standing in its own grounds, with waterfalls, fountains, pergola, and rustic bridges over the streams. The whole thing was designed and built by Mr. C. E. G. Day, the proprietor of the company, who has had wide experience along this line, both in Canada and the Old Country.

The waterproof brick manufactured by the company, while somewhat new here, has met with great success in the United States, and is turned out at practically the same cost as the ordinary clay brick. They control the Shope patents in brick machinery and the process of making this brick, which enables them to make waterproof facings without the use of waterproofing compounds and at the same time secure the modern tapestry and moss effects. Perfect crystalization is also secured, having a surface in which the veins are filled, making it absolutely impervious to water.

From recent tests by the School of Practical Science in Toronto University these cement brick have a crushing strength far in excess of the requirements of modern construction. They are manufactured in a variety of patterns and colors, which make them most desirable not only for a building brick, but for mantles, inside decorations, for theatres, churches, etc.

The exhibit, which is in charge of Mr. Day, can be found opposite to the Grand Stand, next to the exhibit of the Brantford Roofing Company.

Will Call New Tenders

The town of Aylmer, P.Q., on August 29 decided to reject all the bids for a new filtration plant, designed by Mr. J. O. Meadows, Montreal. The council came to this decision on the ground that there had been some misunderstanding on the part of certain contractors, and agreed to call for fresh bids on the same plans and specifications.

More General Use of Concrete Sewers

(Concluded from page 876)

used under any conditions. Mixtures should be of a quaky or jelly-like consistency so that they may be readily spaded around reinforcement, yet should not be wet enough to cause a separation of sand-cement mortar and coarse aggregate. After mixing, the concrete should be transported rapidly to the place where it is to be placed. It should be spaded thoroughly around reinforcement, pipes, or other shapes built into the work, especially on surfaces which are to be exposed to the interior of the sewer so that the sand-cement mortar may be brought to the face, thus producing a dense, watertight surface.

With the use of a concrete of the consistency described, carefully placed in smooth, watertight forms, satisfactory surfaces are obtained for the interior of the sewer. If monolithic concrete sewer construction is properly performed, the same satisfactory results will follow, as in all other correct uses of concrete.

Trade Publications

Circuit Breaker Installations—The Cutter Electric & Manufacturing Company, Philadelphia, have prepared a very handsome book describing a large number of typical I-T-E circuit breaker installations. As stated in the introduction, this book depends for its value upon illustrations rather than intricate technical descriptions, and the illustrations are wonderfully good, many of them full-page size and some of them extending over the two full pages. In all there are some 400 illustrations. The book has 350 pages, size 11 in. by 9 in., bound in red cloth.

New Books

How to build up furnace efficiency—by J. W. Hays, combustion engineer, Rogers Park, Chicago; price $1.00. This is a new edition, revised and enlarged, of the author's handbook on fuel economy. It is divided into five sections:—why your fuel is wasted; how your fuel is wasted; how to "spot" your fuel wastes; how to stop your fuel wastes; how to keep the wastes stopped.

Mainly Constructional

East and West—From Coast to Coast

Montreal Machinery & Supplies, Limited, has been incorporated with a capital stock of $50,000.

The Western Machine Works, Limited, has been incorporated with a capital of $25,000, head office Vancouver, B.C.

Manitoba Steel Foundries, Limited, has been incorporated with a capital of $300,000, headquarters at Montreal, Que.

The Frontenac Red Granite Company, Limited, has been incorporated with a capital of $100,000, headquarters at Gananoque, Ont.

The Mitchell Rail Anchor & Specialty Company, Limited, has been incorporated with a capital of $30,000, head quarters at Montreal, Que.

The Canadian Chicago Bridge & Iron Works Company, Limited, has been incorporated with a capital stock of $100,000; headquarters at Bridgeburg, Ont.

The Canadian Fairbanks-Morse Company, Limited, Toronto, have secured the contract for a motor-driven pumping outfit at Ridgetown, Ont., consisting of two triplex pumps.

One of the chief questions which will be considered at the forthcoming session of the Quebec Legislature will be the proposed new loan of $10,000,000 for improvement of highways.

The Corporation of Palmerston, Ont., have awarded the contract for one 30 h.p. motor-driven vertical centrifugal pump to the Canadian Fairbanks-Morse Company, Limited, Toronto.

As a new departure in their business, the Quebec Scrap Metal and Paper Company, Limited, has taken up the manufacture of ornamental stonework of all kinds as well as concrete for every purpose.

It is reported that at the present time great difficulty is being experienced in obtaining housing accommodation for prospective residents of Galt, Ont., and that desirable citizens are being lost on that account.

The National Bronze, Iron & Engineering Works, Limited, has been incorporated with a capital of $750,000, headquarters Montreal. The firm will carry on the business of mechanical, electrical and chemical engineers.

A new telephone building is being erected at Barrie, Ont., at a cost of $12,500. Pounder Bros., of Stratford, are the general contractors, and W. J. Carmichael, of Montreal, is the architect. The building will be of brick with cement foundation.

The Nicomen Gravel Company, Limited, has been incorporated with a capital of $50,000, head office Vancouver, B.C. The new concern will take over the properties and assets of the Dewdney Gravel Company, Limited, which is in liquidation.

Canadian architects and contractors are expressing considerable dissatisfaction regarding the Dominion Government's action in awarding the contract for construction of the arsenal at Lindsay, Ont., to a United States firm, without permitting any Canadian competition.

A special roads committee of the council of Kent County, Ont., has returned from Wayne County, Michigan, where concrete highways were inspected. The committee gained valuable information and will report at the December session. It is expected that some definite action will be taken at that time by the council towards adopting a good roads scheme for the county.

The council of Chambly Basin, P.Q., have decided to extend their sewage system, and have let a contract to Mr. L. Giguere, Montreal, for the construction of sewers at $15,400. The council have also decided to commence the laying of cement sidewalks on the main street, under the supervision of Mr. Avila Gravel, civil engineer, 17 Place D'Armes Hill, Montreal.

City Industrial Commissioner Davison recently presented a promising report to the civic industries committee of Vancouver, regarding possible developments in that city. Amongst other things, he stated that negotiations were proceeding in regard to the establishment of two steel rolling mills and had advanced so far with one concern that it was probable it would be started within the next few months.

The general contract for the construction of a wholesale grocery warehouse for Campbell, Wilson & Horne at Red Deer, Alta., was recently awarded to Chas. T. Eline, of that city. Work on the excavation was commenced immediately and the building is to be completed in about two months. R. G. Dawe, C.E., Red Deer, is architect and engineer in charge of construction. Cost will approximate $21,000.

In a report which he has submitted to the board of

control regarding his inspection of the Toronto-Hamilton highway in the vicinity of the city, Commissioner of Works Harris, of Toronto, states that at a point about 1,000 feet west of the commencement cracks in the pavement are apparent and from that point westerly for about three-quarters of a mile there are 39 bays cracked, while many of the joints are raised so high that a very decided bump is perceptible in passing over them. The cracks are nearly all longitudinal and vary from hair cracks to a width of 2½ ins.

The Dominion Steel Products' Company have been granted a permit for a $65,000 plant which they purpose to erect in Brantford, Ont. The new building will be 370 x 90 feet and will be constructed entirely of steel and glass equipped with latest machinery for making shells. It will be built by Austin Company of Cleveland, U.S.A., standard factory builders, and is to be ready in sixty days.

Officials of the Toronto and Hamilton Highway Commission charge New Toronto and Mimico with being responsible for the delay in completing the work between the Etobicoke River and the city of Toronto. These municipalities are installing a water and sewerage system on the lake shore, and the officials state that road work is being held up on this account.

It is understood that Feldspar and Clay Products, Limited, recently incorporated with a capital of $1,500,000, have purchased the plant and property owned by the Crown Portland Cement Company at Wiarton, Ont. It is the intention of the new firm to engage in the manufacture of potash. They will get their raw material near Parry Sound, where they have purchased 500 acres containing feldspar.

Ontario County, Ont. has fallen in line with the 21 counties of the province which have adopted the good roads' system, and at a meeting held in Uxbridge town hall sixty municipal representatives from all parts of the county gave formal expression of their approval of the scheme. Mr. W. A. McLean, Deputy Minister of Public Works, was present at the meeting and delivered the principal address.

It is stated that the heavy motor truck and automobile traffic which has developed in the last few years and especially since reciprocity of motor licenses has come into effect, has resulted in severe deterioration on the roads of Welland County, Ont., built under the good roads system adopted in 1912. This system, which provides for a total mileage of 166, of which between 85 and 90 miles have already been constructed, has involved an expenditure of nearly half a million dollars to date. Waterbound macadam has been used in the construction, but it is thought that its continued use is not justified and that some more permanent material will have to be adopted.

The contract for the new Dominion Arsenal at Lindsay, Ont., has been awarded to the Westinghouse-Church-Kerr Company, a United States firm, which has had for some years a large Canadian branch at Montreal. The contract will involve, all told, probably between two and three millions, including both buildings and machinery. The award was made by the Government on the advice of Hon. A. E. Kemp, the Minister who is in charge of the work. Col. Weatherbee, of Halifax, has been given supervision of the carrying out of the contract. It is hoped to complete the work early next year. The Westinghouse Company were awarded the contract, it is said, on account of their extensive experience in this class of work, having built practically all the rifle and ammunition plants in the United States. The materials and plant are purchased on the tender basis, all prices being submitted for Government approval. The company is allowed a percentage on the total value of the work, the rate varying according to the amount of the engineering services employed.

Personal

E. A. James, C.E., engineer for York County, Ont., recently spent a few weeks in the western provinces.

Mr. F. B. Tapley has been appointed an assistant engineer of the Canadian Government Railways with headquarters at Moncton, N.B.

City Commissioner C. J. Yorath, of Saskatoon, Sask., has been offered a captaincy in the Canadian Engineers, which, it is understood, he will accept.

Mr. George A. Walkem, of Vancouver, B. C., has been given a first lieutenancy in the Royal Engineers and sent to Egypt, according to word received by his relatives.

A report has been submitted to the Canadian Fire Underwriters' Association by Mr. R. O. Wynne-Roberts, regarding the fire-fighting facilities of London, Ont., with especial reference to the water supply.

Mr. A. Hastings, who for eight years has been foreman of the Terra Cotta Pressed Brick Company, of Brampton, Ont., has now severed his connections with that concern and accepted a position as superintendent of the Meaford Brick Company, Meaford, Ont.

Lieut. K. G. Rea, Montreal architect, has been appointed to the 245th Battalion Canadian Grenadier Guards, now being organized by Lieut.-Col. C. C. Ballantyne, managing director of the Sherwin Williams Company of Canada.

Mr. L. L. Gisborne, mechanical engineer, who has been in charge of the civic waterworks department of Ottawa, has resigned from the city's service to accept a position as sales representative of a Toronto manufacturing firm. Mr. W. A. Macdonald has now been placed in charge. Mr. Macdonald has been in the civic employ for the past five years and his excellent services have won him his promotion.

Mr. Frank McInnis, of Boston, a waterworks engineer of experience, has been engaged by the city of St. John, N.B., to fill, temporarily at least, the vacancy made by the departure of Lieut. Armstrong, the former engineer of waterworks and sewers. Lieut. Armstrong left for Petewawa to join the 58th Artillery, which is expected to sail soon for overseas service. Mr. McInnis, who is taking his place, is a native of Fredericton and a graduate of the University of New Brunswick. For the past thirty years he has been chief engineer of the Boston waterworks department, and has been responsible for many recent improvements inaugurated there. While his engagement is not announced as permanent, there is a possibility of his remaining in the service of the department.

Obituary

The death occurred recently of William M. Manigault, of Strathroy, Ont., a well-known drainage engineer and a county surveyor for many years. Mr. Manigault was one of Strathroy's best known citizens, having settled there over thirty years ago.

The death occurred recently in Victoria, B.C., of John Nicholson, a very old resident of that district. Mr. Nicholson was 94 years of age, having come to Canada from Ireland 70 years ago. For a considerable time he was engaged in the contracting business. He also held the position of government road superintendent under Sir James Douglas, and later was associated with the firm of McNamee & Company, of Montreal, in the building of the dry dock at Esquimalt.

Armour & Company, pork packers, have called tenders for the construction of a packing house and power house on Craig Street, Montreal. It will be of brick and reinforced concrete construction, and four storeys high. Mr. R. C. Clarke, of Chicago, is the architect.

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Pneumatic Placing of Concrete

IMPROVEMENTS are always being sought for economically and rapidly handling materials. In concrete work, as in everything else, new appliances, new methods and new developments that will lessen labor are welcomed. One of the most recent and practical innovations along this line has been the conveying and placing of concrete by pressure; in general, by pneumatic power. Efforts in this direction have recently been meeting with a considerable element of success, and the method has been tried out on a number of important jobs with quite satisfactory and, indeed, encouraging results. We confidently believe that this opens up a new field and that as more experience is gained radical changes in our methods of handling concrete will ensue.

On another page of this issue, there is published an article describing the general principles involved and their application in a number of particular instances which, no doubt, will prove timely to those interested in concrete construction. The nature of the work in which these methods were employed and the variety of arrangements and equipment involved open up a new phase in construction processes.

A perfected system of pneumatic mixing and conveying would, no doubt, prove revolutionary in its effect on many kinds of work. In sewer or tunnel work, where space is limited, pneumatic methods would abolish inconvenient mixing and transportation, with the further advantage of having stock and equipment located at almost any desired spot. A pneumatic installation possesses great elasticity, inasmuch as the pipe line can be accommodated to curves, inclines or vertical lines, and to any distance up to 3,000 feet. The equipment is easy to shift from one job, or part of a job, to another. A point worthy of special note is that the material can be disposed in narrow or almost inaccessible places and the action of the pressure deposits it without the necessity of tamping. The article referred to mentions several instances in which these advantages were especially apparent.

A more recent innovation is a device for combining mechanical mixing with pneumatic delivery, which, it is claimed, indicates a marked advance of efficiency in this method of distributing concrete. More definite results are eagerly awaited.

There can be no doubt but that the principles of pneumatic placing have much to commend themselves. A few years' experience will, it is claimed, place the process on a practical and paying basis; there seems to be much that presages success where convenience, simplicity and compactness will be advantageous.

The Bloodless War of the Future

Now that European countries are otherwise engaged, it would appear to be an opportune time for our manufacturers of every kind to consider immediately how they may place their products on foreign markets where competition has heretofore been too keen for us. As has been frequently pointed out, the value of a "Made in Canada" slogan is very much circumscribed if the market is confined to our own Dominion. If this slogan really stands for "quality" and "service" it should find its greatest usefulness outside our own borders. One of the greatest mistakes our manufacturers have made in the past, we believe, has been in trying to hold the home market entirely for themselves, for by so doing they have automatically shut themselves out from other more profitable and populous markets. United States manufacturers constantly claim that there is much less profit to be made in Canada even at the higher prices prevailing, on account of the limited demand spread over such a large area. It is opening an old sore, of course, to discuss the interchange of products with the United States on a mutually advantageous basis, but the wisest of men change their opinions sometimes, and on every side there is evidence that our manufacturers are themselves coming to look upon this idea with favor—a change of heart probably born of the feeling that our products have the quality behind them that will sell them against any competition. It will always be true that the cost of production, and therefore the selling price, is regulated by demand, and for that very reason we ought to do everything in our power to extend our markets.

Little as we now respect our European enemy, we cannot but admit the success of the German governmental policy of assistance to her manufactures, and the German policy has always been diametrically op-

posed to the Canadian policy. Here in Canada our governments have encouraged the manufacturers to stay at home by making it difficult for outsiders to come into the home market. Over in Germany, on the other hand, they have assisted the marketing of home products abroad, leaving the home market to take care of itself. This it automatically did, because the greater quantity of production kept the prices low enough at home to kill all competition from outside. Thus at the same time the people of Germany enjoyed low prices and the factories of Germany prospered because of their extended markets.

As against this, we in Canada have always paid abnormally high prices for most of our manufactured products and Canadian factory products are strangers in almost every country in the world except our own.

But the present time is surely an exceptionally favorable one to profit by our own mistakes and take advantage of world markets that at the moment are going begging, and it is distinctly encouraging to note that our Dominion Government is meeting, some time in the near future, with manufacturers of every kind from all points in Canada, having in view a discussion on how our products can best be placed in those markets which formerly were supplied from Europe, especially from the central powers with which we are at war. It is important that we should act promptly in this matter, for there is no shadow of doubt that commercial competition will be keener than ever after the war. This being so, it is scarcely possible to overestimate the advantages of having our products established before the war ends.

The date of this convention has not yet been announced, but a quantity of literature has been, and is being, sent out, calling upon manufacturers to consider this question thoughtfully and carefully, so that they may come to the convention prepared to discuss ways and means. We trust that manufacturers will unanimously take advantage of this opportunity offered by the government, as it indicates the latter's willingness at least to consider supplying such support as is necessary to place Canadian products on foreign markets under conditions that will make the business attractive and profitable.

Freight Service on Montreal Tramways

As the city of Montreal will take under consideration the granting of a new franchise to the Tramways Company, the Builders' Exchange have taken the occasion to ask the Board of Control to make provision for a freight service. The petition, signed by many large contractors and supply firms, was presented on September 1st, by a deputation composed of Mr. John Quinlan, President of the Builders' Exchange, and Messrs. W. C. Munn, Robt. F. Dykes, A. Bremner, Jas. Laurin, and David K. Trotter, Secretary of the Exchange. It was asked that freight be carried at times when it would not interfere with passenger traffic, and it was also asserted that this would lead to a reduction in the cost of building. Mr. Quinlan pointed out that at one time stone was quarried and brick was manufactured in the centre of the city, but these industries had been necessarily changed. While there was an abundance of clay and lime on the Island of Montreal, the cost of haulage by teams was so heavy that the manufacture was not profitable. It was also difficult and costly to dispose of surplus material from the deep excavations for the large buildings—all these causes making for increased cost of building and rent. Mr. Quinlan suggested that excavation material, lime, stone, brick and sand could be cheaply transported by the Tramways Company. What was required in the interests of the building trade, and incidentally the Island of Montreal, was that the Tramways Company should be required to have loading and unloading stations in all parts of the city and be compelled to carry freight to and from these stations, at a fixed price per mile. They should also be compelled to freight from railway and steamboat stations at night, if necessary, to the different warehouses in the city.

The Outlook for British Engineers in Canada

Is it not possible that when the Great Crisis is over many of our returned engineers may look to Canada for a fertile field for the exercise of their professional skill? If so, our advice to them would be, emphatically, Don't! We have it on excellent authority that most of the towns and cities there have spent so much in the past, and the war has caused such a great setback, that it will take a long time for them to revive the stage when the services of consulting engineers will be needed frequently. Moreover, practically all the plums in this line are given to American engineers. For many reasons there is a strong tendency to select them, while the next choice falls to Canadian-born engineers. It is generally held that American methods and ideas are best suited for Canada, and no doubt this belief is sedulously fostered by interested Americans. Anyhow, men from the Old Country are not encouraged, and it is well this should be put plainly.—The Surveyor, London.

Conference of Paving Brick Manufacturers

The National Paving Brick Manufacturers' Association has arranged the details necessary for a study and conference in brick pavement construction, to take place Friday, October 6th, at Paris, Illinois. The annual business meeting of the Association will be held October 5th, 10 o'clock a.m., at the Deming Hotel, Terre Haute, Indiana. Headquarters of the occasion will be the Deming Hotel, Terre Haute, Indiana, from which place those participating in the paving conference will go by interurban railway to Paris, Illinois—an hour's ride—where the construction demonstration will take place, which will consist largely of steps showing the economy of construction details in building a brick pavement by laying the brick in green mortar. An important purpose of the effort will be to show how such a pavement can be built with the least possible cost and yet maintain all the essentials of worth. All persons connected in any way officially, or those deeply interested in the roads of this country will be made welcome at this conference. It is undertaken, no less in behalf of the brick industry, than in the sincere belief that the country itself is bound to be profited by such an opportunity.

The Great Northern Railway Company's handsome terminal depot at Vancouver—a perspective view of which was recently presented in these columns—is now nearing completion as far as the exterior is concerned. Messrs. Grant, Smith & McDonald have been awarded the contract for the new freight sheds to be erected on the False Creek tide-flats adjoining the new depot at a cost of about $25,000. The sheds will be 50 x 600 feet.

Concrete Linings for Irrigation Canals

The Desirability of Protecting Earth Banks Against Seepage Losses Have Promoted the Use of Concrete for this Purpose

SUCH dry seasons as the past one, which has materially lessened the production of grain, roots, fruit, etc., throughout various districts in Canada, naturally directs our attention to the possibility of making ourselves more or less independent of these elements in nature over which we have so little control. In Western Canada considerable progress has been made with irrigation, but in the East we are still dependent upon the somewhat irregular dispensations of Providence. However, the old idea on which we have worked with varying success for so long, that we are given what is best for us, is losing ground and being replaced by the modern interpretation that "Heaven helps those who help themselves." That being the case we now have both moral and commercial reasons for supplementing our rainfall with something a little more dependable and the subject of irrigation is receiving much more attention. The present paper deals more particularly with the latest methods of constructing the distributing mains, as practised in Western Canada and the United States.

Profitable development of irrigation projects is dependent upon the value which the water available will have in making and maintaining productive the acreage which the supply will irrigate. In most cases all of the available water is used, either by being actually distributed over the area to be irrigated or by losses due to seepage and other causes in transit.

Studies conducted by the United States Department of Agriculture seem to prove that from 25 to 40 per cent. of the water taken in at the head of main canals is lost by absorption of the earth banks. Measures that will prevent this loss mean that the available water at the source of supply, if conserved against such preventable waste, can be made to reclaim a large additional acreage, thus contributing greatly to the profit of an irrigation enterprise. Losses from evaporation cannot be entirely prevented. They are, however, relatively insignificant.

The desirability of preventing losses from seepage was recognized about ten years ago in California, and early experiments to prevent them were made by applying crude petroleum to the earth faces of ditches with a view to preventing absorption and seepage. These experiments were conducted in Kings County, California, by the Lemoore Canal and Irrigation Company. This company shortly afterward discontinued the practice mentioned, evidently because results were not satisfactory. Investigation has shown that so-called oil lining is not effective for a very long period.

In some sections of the west it was once common to line leaky portions of canals with lumber, especially when lumber proved itself cheaper than concrete because of the price of cement; but the conditions under which wood was thus used were most favorable to its short life through decay.

Extensive Use of Concrete.

No other construction material has been used to so great an extent as concrete in developing irrigation projects. Since the Government first began, in a systematic way, the construction of dams and associated structures to impound and distribute water to reclaim the arid and semi-arid lands of the west, concrete has been used almost to the exclusion of all other construction materials. This use has not by any means been confined solely to the larger or more important structures or parts of them. The high cost of maintaining flumes and the increasing cost of lumber, as contrasted with the decreasing cost of cement, have resulted in the practice of lining irrigation canals with concrete.

As water rights in connection with various irrigation projects sell for from $25 to $50 per acre, it can be seen that the value of water varies considerably, this perhaps being caused often by geographic location, which determines how urgently water is needed. All means that will tend to prevent losses in transit will naturally increase the acreage possible to reclaim or irrigate.

One of the ever-present possible causes of loss from unlined ditches and canals is that banks may break, thus throwing an entire system or a large portion of it out of commission until repairs can be made. These happenings are expensive usually because they occur at a time when water is most needed for crops. In such cases the loss due to absence of water is generally far greater than the actual cost of repair to the canal. An instance of this kind occurred on the unlined Turlock Canal in California, in 1910. The fundamental cause of this break seemed to have been due to a gopher burrowing into the banks, thus causing a leak and rapid erosion which finally resulted in the washing away of about 1,000 feet of embankment. In this case the canal was out of service for six weeks, during a period when water was most needed for crops. The cost of actual repairs to the canal was $20,000, while the estimated damage to crops was $1,000,000.

Value of Lining.

In determining the value of any material proposed for lining irrigation canals or ditches, it is necessary to compare the cost and possible benefits of the work. Unlined irrigation canals or ditches are of lower first cost than concrete-lined ones, but they require continual maintenance to keep them at maximum efficiency. Erosion of the soil, caving of banks, growth of vegetation, are all obstacles to maintain maximum flow of water. Necessity for continually cleaning the canals to restore them to their original or desired section and efficiency is therefore a perpetual expense. Concrete lining does away with all of these troubles; it prevents animals from burrowing through the banks and, if properly constructed, is permanent.

Having all the recognized desirable qualities for canal lining, the use of concrete for such purposes is rapidly growing. Records show that concrete was first used in this manner about 1880, in southern California, when the increasing value of water in that locality for land reclamation made it imperative to reduce seepage losses; and although these early linings were more or less experimental, in that no standard practice for the work had been developed, the results were so satisfactory that concrete lining was

adopted for practically all canals in that section of the country.

An examination of literature issued by the United States Reclamation Service proves that since then, concrete lining has been used extensively throughout the west and in British Columbia.

Concrete linings for irrigation canals have other advantages besides those already enumerated. The smooth surface of the concrete secures a higher velocity of water and permits a smaller and more desirable shape of section for the canal, which materially decreases the cost of excavation. Steeper grades, where necessary, and better alignment, may also be obtained. The resulting economies in cost can be shown and, in a short time, prove the profit of the investment from the standpoint of eliminating depreciation and upkeep on unlined canals.

Increasing Efficiency.

Although the alignment and grade of old earth canals cannot be materially changed without almost prohibitive expense in some cases, nevertheless, the efficiency of such canals can be increased from 25 to 80 per cent. by removing irregularities so as to restore the canals to their original section, and making these improvements permanent by lining with concrete.

Studies of the Reclamation Service seem to have proved that where possible, steep grades, with corresponding high velocity of water, are best, if economy of conveying water is the only consideration. But in practice high velocity of water flow is not generally desired, because to provide for it considerable added expense is necessary for suitable turnouts, requiring increased height of lining to take care of the pulsation caused by the rapid flow.

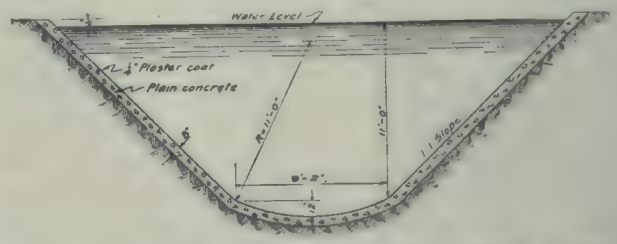
Where canals follow hillsides, the possibility of breaks in the lower bank may readily be prevented by concrete lining. Errors of faulty location followed by weak places in the canal can often be remedied effectively by concrete lining. Likewise, where the original grade of the canal is such that considerable scour occurs, or where excessive curvature results in undercutting of the sides, concrete lining removes the trouble.

Even though many miles of irrigation canals have been concrete-lined, the practice has not by any means yet been standardized. In fact, each irrigation enterprise involves many problems peculiar to itself. The design of canals depends upon so many factors that each problem must be solved independently, and what seems to be best practice applied in each case. As regards the use of concrete, however, the same fundamentals of good work apply in this field as in any other. Where failures in concrete linings have occurred they have almost invariably been traced to faulty methods of design, inferior materials, and careless workmanship.

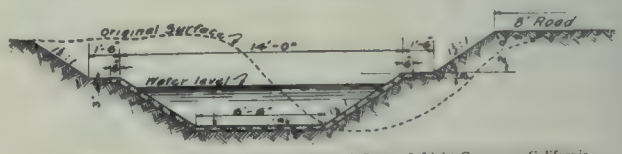
So far as the cement is concerned, any brand meeting the specification requirements of the American Society for Testing Materials may be used. Sand and pebbles or broken stone should be carefully selected so as to secure the best of these materials. The sand should be coarse, clean, well graded and free from alkali. If sand of suitable grading is found at or near alkali deposits, it should be washed thoroughly with water that will remove any excess of alkali. Pebbles and broken stone also should be clean, hard, durable, non-porous and well graded. The sand should be obtained by screening natural bank-run material through a screen that will pass all particles one-quarter of an inch and under. The pebbles and broken stone should be graded uniformly from this size upward to a maximum dimension not greater than 1½ inches.

Correct Mix.

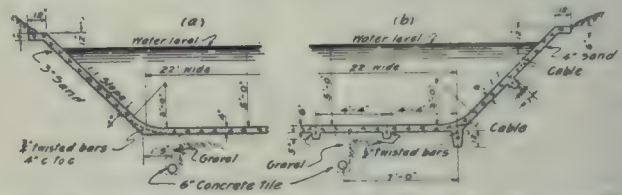
Accounts of early practice in lining irrigation canals with concrete show that very arbitrary mixtures were used for the work. The fact that such construction has stood up under the service required of it is no proof that the work is what it should have been. In all cases the proper proportions of cement, sand and pebbles should be determined by field tests so that mixtures can be correctly proportioned to make certain that voids or air spaces will be reduced to a minimum and dense concrete secured. A mixture of 1 sack of



Cross section of concrete-lined channel of the Los Angeles Aqueduct, California. The bottom is in the form of an invert.

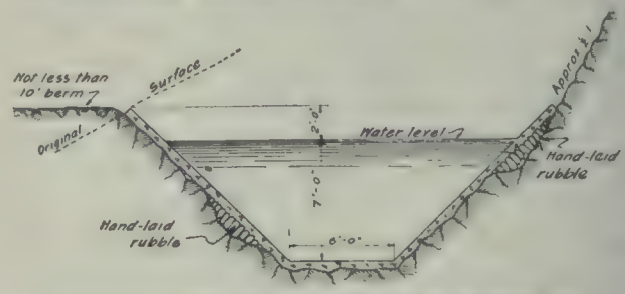


Cross section of concrete-lined canal of the Burbank Power & Light Company, California



(a) General type of concrete construction used in lining the Davis and Weber Counties Canal, Ogden, Utah. The bottom is rounded where it joins the sides and reinforced with ¼-inch twisted bars 4 inches center to center. Drainage is provided for the foundation by laying a line of 6-inch concrete tile.

(b) Type of concrete lining used on the same canal where the foundation is likely to prove unstable. This design incorporates a feature which is essentially that of a reinforced concrete beam.



Concrete-lined canal section, Medina Valley Irrigation Company, San Antonio, Texas

Typical sections of concrete-lined irrigation canals in the West.

Portland cement to 2½ cubic feet of sand, to 4 cubic feet of pebbles or broken stone will, if the sand and pebbles or broken stone are properly graded, produce a concrete which will have the required strength and water-tightness. Concrete should be machine-mixed in a mixer of the batch type, using sufficient water to form a mixture that will be just as wet as possible to handle on the ditch slope and prevent it from "flowing" out of place. Certain conditions may require that the concrete be reinforced. These can be determined only from a knowledge of the situation to be met.

Care must be taken after the concrete has been placed to protect it from hot sun, wind and other influences that would cause it to dry out rapidly. Un-

less so protected, much of the otherwise possible good results will be lost. A protective covering of moist earth or a shelter of canvas should be placed over the concrete as soon as possible to do so without marring it, and this protective covering be kept wet by sprinkling, if possible, for several days.

It is not possible to recommend an invariable thickness for linings of canals excavated in natural soil as this will depend largely upon the nature of the soil, and the water to be carried. Where concrete linings are laid on firm soil, reinforcing is probably unnecessary. If necessary, however, to line a section of canal that is in rather unstable soil, reinforcing is advisable, as this practice will be likely to prevent cracks from settlement. Canals and ditches should not be located on or through fills if possible to avoid such location.

Contraction Joints.

Contraction joints in concrete linings are necessary to prevent cracks that may occur from variations in the volume of the concrete due to temperature changes, that is, to alternate expansion and contraction. Practice in the past has been to place joints at too short intervals and sometimes to use a poorly designed joint. Although it is not within the province of this article to recommend any particular type of joint, it may be stated that a good contraction joint should provide for the expansion and contraction likely to occur without disturbing the continuity of the lining by too wide a joint space, and should also permit a certain amount of "creeping" without misplacement.

The result of omitting contraction joints from concrete linings was well illustrated in a portion of the main lower Truckee Canal, Nevada, constructed in 1904-5 by the United States Reclamation Service. On this work a good deal of the lining was placed without contraction joints. In 1911, an examination of the canal showed that the lining had cracked at quite regular intervals of about 28 feet. These cracks varied in width from 1/12 to ½ inch or more when the temperature was 50 degrees and that of the water was 42 degrees, Fahrenheit.

Construction methods in lining canals with concrete vary widely in different sections of the country. Industrial tracks and cars are found economical on large jobs. Here again each particular piece of construction is a special problem.

Certain bad practices of the past in lining irrigation canals with concrete are being eliminated as a result of recent studies and investigations. The commonest fault seems to have been haphazard methods, or at least very arbitrary ones, of proportioning the concrete mixtures; also lack of uniformity in placing contraction joints. In many cases it is now recognized that wrong methods were used even though the work may not yet have had time to disclose bad practice. Even though a concrete lining may show no appreciable defects in from two to six years, it need not necessarily be inferred that the workmanship or methods employed were requisite to the desired ends.

Durability.

The durability of concrete lining depends not only on good design and construction, but also on the conditions of use to which it is subjected. Sudden changes of temperature brought about by quickly emptying the canal of cold water and exposing the lining to hot sun, damage from roots of trees, storm water and live stock, may be fundamental causes of injury to good construction. Trees should not be allowed to grow near the banks of the concrete-lined canal, as eventually the roots are certain to heave the concrete slabs. Provisions should be made to by-pass the storm water of cloud-bursts or heavy storms, as the sudden flows coming from such causes may raise the water in the canal to such a height as to endanger the safety of the lining by washing away the earth backing.

If canals are to be operated during freezing weather, damage from ice may largely be prevented by increasing rather than diminishing the flow of water before temperature drops to the freezing point. This will raise the water level, thus exposing a greater surface of water in the canal and tend to make an ice sheet, if it forms, bulge upward and thus relieve the lining from side thrust. Generally, however, the slope of ditch sides is such that there is little danger of injury from the formation of ice.

Use of Concrete Pipe.

There is another practical use of concrete in connection with irrigation development that has not by any means been extended to possible limits. This is the use of concrete pipe, either plain or reinforced, as conditions may require, to carry the water in laterals, or in some instances, even to build main canals. The advantages of concrete pipe for this work are that where suitable materials for concrete are not to be found at the exact site of work, the pipe can be made in a central plant, where materials are available, and all necessary measures can then be applied to properly harden the pipe, thus insuring that the concrete is of high quality. It is no doubt difficult sometimes to give the concrete all desirable protection against rapid drying out where ordinary lining is laid, and pipe manufactured in a central plant and properly hardened by approved methods would insure a good concrete product on the job.

In the various irrigation developments which have been carried on under the work of the United States Reclamation Service, concrete pipe has in some instances been quite extensively used as described. In the Umatilla project in the northwestern part of Oregon, a number of pressure pipes are required to distribute the water, on account of irregular topography of the lands reclaimed. When the plans of the distributing system were first being repaired, some doubt existed as to the kind of pipe to be used. Wood pipe, from the standpoint of first cost, was admitted to be the cheapest type available; but when it was considered that the pipe would be in use only about seven months a year and would be dry wholly or in part for five months, it was evident that wood pipe was likely to fall far short of requirements. Steel was considered too expensive, and there was some uncertainty as to its probable length of life in the soil to which it was to be exposed, so the final decision of the engineer was to use reinforced concrete pipe. These were 46 inches in diameter, manufactured on the site. In use they are subjected to a maximum head of about 55 feet; 4,700 feet of such pipe were used in the first instance and, so far as is known, have proved satisfactory.

Reinforced concrete construction was also used in 2.14 miles of pipe for the Antelope Valley Siphon of the Los Angeles Aqueduct, California.

A 12-mile conduit of 36-inch concrete pipe was built down the canon of the Middle Boulder Creek on the east slope of the Rocky Mountains in northeastern Colorado as a part of the hydro-electric development of the Eastern Colorado Power Company. These pipe also were made at convenient points on the job.

The conditions under which they are used submit them to considerable pressure, but in service they have been eminently satisfactory.

Another instance of the use of reinforced concrete pipe in reclamation work may be found on a portion of the Yakima project, in Yakima Valley, Washington. Here, some 2,825 feet of 30½-inch concrete pipe are used in what is called a "feeder" canal. The type of pipe used and the methods of construction were similar to those used on the Umatilla project, previously mentioned. The central pipe yard was so located that the average distance of haul for pipe was about 1½ miles.

On the Boise project, Idaho, the United States Reclamation Service used 8,575 feet of reinforced concrete pipe 42 inches in diameter. In service this pipe is frequently subjected to a head varying from 60 to 70 feet.

It would often no doubt be found advantageous to use concrete drain tile or pipe to conduct water from main ditches or canals to points where it is actually to be distributed over the land.

Progress of New Toronto Union Station

Since the progress at the new Toronto Union Station was last mentioned in the Contract Record of July 26, work has been steadily advancing, although handicapped to a very large extent by slow deliveries of materials and by lack of labor. In spite of this, Toronto's new station is beginning to take shape at last and there is every indication that within a short time the skeleton will be completed.

The Canadian Bridge Company, who are the contractors for the steel work, expect to complete the assembly of the structural frame for the two end wings on which they are now working, by the end of the present month. The central portion will be started immediately after. On the west wing the steel has been erected up to the roof and is practically finished, while the east side is nearly as far ahead. These two wings each measure nine bays long by seven bays wide, each bay being about 26 ft. by 23 ft. When complete, these two portions will contain 1,700 tons of steel apiece, and the whole structure will have 6,500 tons. Only conventional methods of erection have so far been employed, since the advancement has been too slow to warrant any novel or out-of-the-way schemes. Steel is delivered on flat cars to a siding directly on the site and unloaded by locomotive cranes. Four huge derricks, two on each wing, handle the steel and set it in place. These derricks have 100-foot masts and 85-foot booms, with capacities of 15 tons each. Their top and bottom bearings are equipped with ball races, enabling one man to handle each quite easily. These are unshipped and re-set every two floors. All steel columns come assembled in two-storey lengths. Riveting is done by pneumatic hammers. The general floor layout is to have I-beam girders between the H-section columns, with beams at the third points of the span.

West wing of Toronto Union Station showing central roof trusses.

Concreting of the steel and floor has already begun on the west wing. The columns, girders and beams are covered with a single layer of large mesh, expanded-metal reinforcing and coated with concrete as a protection against fire and moisture. Wooden forms are used to retain the concrete. Flat slab concrete floors are laid on wood centering between the beams with twisted square steel reinforcing rods in two directions and bent to go over the beams. Concrete is mixed in the basement and elevated to the required floor, where it is distributed by buggies to the point of pouring. At present the ground floor concrete is reaching completion. All wood forms are made on the site, a circular saw, driven by a gas engine, being used to cut the wood. All rod bending is also done on the job.

Sub-basement of new Toronto Union Station showing arrangement of reinforcement

The sub-basements are now being concreted. The reinforcing consists of twisted square rods. One illustration herewith shows the general arrangement of the sub-basement reinforcing for both walls and floor. Concrete foundation piers can be seen exposed with the rough portion at the base where the wood sheeting did not reach.

The other illustration shows the steel work on the west wing with the skylight trusses spanning the longitudinal corridors. The derricks can be seen, and, on the extreme right, the concrete hoisting tower. The first load of cut stone is already on the ground, giving promise of future rapid developments.

Sewage Disposal Works at Moose Jaw, Sask.

By W. H. Greene, A.M.Can.Soc.C.E.*

The works are situated one and one-half miles east of the centre of the city, on the north bank of Moose Jaw River. They were constructed in 1911, with additions in 1914, 1915, and 1916, at a total cost of $192,661.00, and consist of detritus pit and screen chamber, pump house, sedimentation tanks, bacteria beds, sludge drying beds, disinfection chamber, and humus pond. They are operated by the City Engineer's Department, under the direct supervision of the writer.

Operation.

The sewage, on arriving at the works, passes over a detritus pit, in which sand and other heavy mineral particles are retained. It then passes through a bar screen, and flows into the pump well, from which it is lifted by pumps and forced through a long pumping main into the sedimentation tanks, which are operated on the septic principle. These tanks are sludged by means of a Preistman ejector, placed in a well to the south of Tank No. 3, and to which the sludge flows by gravity through a 12-inch pipe extending under the tanks and with two openings, controlled by valves, into each tank. Before sludging the supernatant liquid is drawn off by means of floating arms, is conveyed back to the screen chamber, and comes through the works again. The sludge is pumped to the drying beds, and when sufficiently de-watered is hauled away to the nuisance grounds and wasted.

The liquid effluent from the sedimentation tanks then flows over the bacteria beds of the percolating filter type, being distributed by Ham-Baker automatic travelling distributors. This system of distribution was installed some six months ago, superseding Stoddart dripping trays. After passing through the beds it is collected in open-jointed tile pipe placed on the concrete floor of the beds, flows into the laterals, and thence into the main effluent channel, which conveys it through the disinfection chamber into the humus pond. In its passage through the humus pond the oxidized suspended solids from the bacteria beds are deposited and the clear effluent flows out into Moose Jaw River.

Composition of the Sewage.

The sewage is a strong domestic one, containing some trade waste, particularly that from a large abattoir and a small brewery. However, the percentage of flow from manufacturing plants is very small in relation to the total flow. Following is a typical analysis, parts per 100,000:

Temperature, Fahr.	46°
Solids—Total	251
Dissolved	150
Suspended	101
Oxygen consumed, 4 hours at 20° C.	9.2
Free ammonia	6.87
Albuminoid ammonia	2.15
Nitrites	trace
Nitrates	nil
Chlorine	27
Alkalinity	53

The samples were collected at two-hour intervals throughout the twenty-four hours and mixed in proportion to the flow. Sewage is sampled after passing through a bar screen, with openings between the bars of one and one-quarter inches.

Detritus Pit.

This pit is small, as the sewage contains very little sand or mineral matter owing to the sewerage system being on the separate plan. It is cleaned out by hand from time to time. Between this pit and the pump well is a bar screen 9 feet in width and 4½ feet in depth, inclined in the direction of the sewage flow and making an angle of 60 degrees with the vertical. The openings between the bars are 1¼ inches. This screen is cleaned by hand-rakes, the screenings being immediately placed in a covered steel tank wagon. This wagon is hauled to the incinerator every morning and the contents burnt.

Pump House.

The pumping equipment consists of two Preistman automatically operated ejectors, supplied with compressed air by two motor-driven air compressors, an eight-inch steam-driven centrifugal pump, which draws its steam from the incinerator, and an eight-inch motor-driven centrifugal sewage pump. The motor-driven pump is just being installed. The steam pump is used whenever steam can be obtained, but as the incinerator is only in operation for eight hours per day and, further, as steam is not available when the garbage is very wet, only 24 per cent. of the total pumpage is done by this unit. Up to the present the balance of the pumping has been done by the ejectors, but as this form of pumping has proved expensive, it is the intention to use the new centrifugal pump and keep the ejectors as a standby.

Included in the equipment now being installed is a sewage venturi meter, with a registering indicator recorder. This will supersede the weir measurements made up to the present.

Sedimentation Tanks.

There are three, each 62 feet long, 24 feet wide, and from 7 feet 6 inches at the ends to 9 feet 6 inches at the centre in depth. However, the effective length of tanks Nos. 1 and 2 is only 58 feet, while in No. 3 it is 55 feet, the feeding channels and outlet weirs reducing them to this extent. Hence, while the capacity of each tank is 81,000 imperial gallons, the effective capacity is only 75,000 gallons for Nos. 1 and 2 and 72,000 gallons for No. 3. As originally constructed, these tanks were on the continuous-flow principle, with penstocks and decanting valves for the removal of sedimented sludge before it became septic. In 1914 tank No. 1 was altered by the addition of inlet and outlet weirs, the direction of flow being changed from across the tank to lengthwise in the tank. The addition of these weirs also allowed the sewage level to be raised eighteen inches, with a consequent increase in sludge-storing capacity. Colloidal plates were also suspended throughout the length of the tank. In 1915 tank No. 2 was altered to the same type as No. 1, but without the addition of colloidal plates. Immediately after, tank No. 3 was altered to a two-storey type by the addition of four wooden troughs, each trough having a sectional area of 12½ square feet. The sewage is fed into the tank from submerged orifices in a channel extending

* Assistant City Engineer, Moose Jaw.

across the tank at the centre, and flows to the outlet weirs, one at each end of the tank. The troughs are provided with baffle walls to prevent surface velocity.

Sludge is allowed to collect in all of these tanks to a depth, measured at the centre, of 5 feet 0 inches, this usually taking about 65 days. When this line is reached the tanks are sludged, as previously described in this article. The average detention period is 4¼ hours for Nos. 1 and 2 and 1½ hours for No. 3.

Owing to the short digestion period—about 65 days—the sludge has a very heavy odor. Before being run to the drying beds it is treated with a deodorant, a coal tar disinfectant now being used. The deodorant is mixed with water in a tank, which is connected by a pipe to the sludge ejector. Every time the ejector fills, a portion of this mixture is drawn in, and when discharged out on the beds, is mixed throughout the sludge. In addition, after the bed is filled, the surface is sprayed with the chemical until entirely covered. When this covering has evaporated, usually one or two days after treatment, the surface is again sprayed, and this has been found sufficient even in the hottest weather. With this treatment no offensive odors can be noticed, even in the vicinity of the beds.

Bacteria Beds.

The number of beds is 13; area of each bed, 204 square yards; cubical contents of each bed, 498 cubic yards; total area, 2,652 square yards; total cubical contents, 6,474 cubic yards; number of distributors, 13; length of travel of distributor, 131 feet; width of each distributor, 14 feet; depth of filtering media, ends, 6 ft. 4 in.; centre, 8 ft. 4 in.

The size of the filtering media varies, being for beds Nos. 1 to 7 of 3-inch crushed stone, with a top dressing of 1¼-inch crushed stone one foot in depth, and for beds Nos. 8 to 13 of 2½-inch crushed stone, with a top dressing of 1¼-inch crushed stone one foot in depth. The rate of treatment is 380 imperial gallons per superficial yard for 24 hours, or 155 imperial gallons per cubic yard of filtering media for 24 hours, as two beds are rested each day. This gives each bed one day's rest per week, and since this rule has been put in practice no trouble has been experienced with the filters ponding.

The entire plant is housed in metal-clad buildings, which, with the exception of the pump house, are not heated. Although in the winter the temperature drops to as low as 50 degrees below zero, no trouble with frost has been experienced. The temperature inside the buildings is taken on recording thermometers, and the lowest figure reached last winter was 35 degrees.

Sludge Drying Beds.

There are six beds, with a total area of 2,421 square yards. All are provided with open-jointed tile pipe underdrains, which carry the drained-off liquor back to the screen chamber. These drains are covered with 18 inches of 2-inch crushed stone, and this in turn is covered with about 5 inches of cinders, which have passed through two thicknesses of ¼-inch mesh screen.

Usually the beds are filled with sludge to 10 inches in depth, and in favorable weather dry out sufficiently for emptying in two weeks. During the winter months the sludge freezes shortly after being discharged, so the beds are completely filled and not emptied until about June, by which time they are thoroughly dried. The dried sludge is hauled to the nuisance grounds in dump wagons, the round trip being about 2½ miles.

Humus Pond.

This pond is formed by earth embankments and holds about 300,000 gallons. The deposited solids from the effluent are cleaned out once a year and used for filling in the banks.

Operating Costs.

Very little is published regarding the cost of operating sewage works, so the following costs are for the year of 1915:

Screen chamber and detritus pit	$ 279.67
Pump house	6,632.63
Sedimentation tanks—Cleaning	158.48
Sludging	339.49
Valve repairs	36.75
Bacteria beds and distributors	651.96
Sludge beds—Dressing	221.10
Emptying	1,003.34
Testing laboratory	355.90
Humus pond	135.04
Lighting	256.65
Heating	80.83
Water	366.10
Miscellaneous	401.42
Fire insurance	361.98
Employers' liability insurance	77.82
Portion of engineer's office expense	316.91
Total cost	$11,676.07

Note.—Electric current costs 2 cents per kw. h. for power and 7 cents for lighting. The charge against the testing laboratory is principally for equipment and utensils.

General Data.

Population	20,000
Total sewage treated, imperial gallons	311,411,000
Sewage per capita per day, gallons	43
Total gross pumping cost	$6,632.63
Average total head, feet	23
Cost of pumping per million gallons	$21.29
Tons of dried sludge removed from beds	1,070.2
Total cost of removal	$1,003.34
Removal cost per ton	$0.937
Cubic yards of wet sludge removed from tanks	2,364
Total cost of removal	$339.49
Removal cost per cubic yard	$0.143
Imperial gallons of sludge obtained per million gallons of sewage treated	2,052
Tons of screenings from 30th May	21.76
Total cost of removal	$152.85
Removal cost per ton	$7.02

Note.—No record of the screenings was kept previous to May 30.

Cost of treatment at works per million gallons—	
Net	$16.19
Gross	$37.49
Cost of treatment per capita per year—	
Net	$0.252
Gross	$0.584

Note.—The net cost is the total or gross cost, less the pumping cost.

Testing Laboratory.

This is now well equipped, and quantitative analyses are made by the writer once a week for:—total, dissolved and suspended solids, oxygen consumed in four hours at 20 degrees C, free and albuminoid ammonia, nitrogen as nitrites and nitrates, chlorine, and alkalinity. Samples are also incubated for seven days and again tested for oxygen consumed in four hours. Samples of the effluent from each filter bed are incubated for relative stability as measured by the decoloration of methylene blue. Complete analyses are made simultaneously of the sewage, bacteria bed effluent, and the final effluent, while the effluents from the three sedimentation tanks are tested separately for total, dis-

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Municipal Filtration Plant at Orillia, Ont.

THE town of Orillia, Ontario, obtains its water supply from Lake Couchiching, which source of supply is at times turbid and subject to sewage contamination, necessitating filtration to make it potable. In order to safeguard the public health, the Orillia Water, Light and Power Commission decided to install an up-to-date filtration plant, which is now in successful operation.

The plant installed is of the "pressure type," consisting of five filter units. The pumps take the water from a pump well, after it first has passed through a sedimentation basin, which basin is fed from the lake by gravity, and force it through the filters either to the stand-pipe or, as in the case of fire, directly into the distribution system.

Each filter consists of a steel shell built of heavy boiler steel, 8 feet in diameter by 18 feet long. The interior of the filters is provided with a filter bed consisting of specially mined and screened quartz gravel and quartz sand. Below the filter bed is a strainer system consisting of numerous bronze strainers, of which there are about 550 in each filter. The unfiltered water is admitted on top of the filter bed, through which it percolates and is collected by the strainers.

Interior of Filter House at Orillia, showing the Mechanical Filter Units.

At regular intervals, at least once a day, each filter is washed with a reverse current of filtered water entering the filters through the strainers, rising up through the filter bed and carrying off the accumulated impurities into the sewer. In order to help this washing process the filter bed is first agitated with a flow of air, under pressure, furnished by an air blower. The air is distributed under the filter bed and directly above the strainer system by means of a grill-work of small perforated bronze tubes. The air not only agitates the filter bed, thus making sure that the applied wash water reaches every particle of the filter bed, but it also refreshes and sweetens the filter bed, carrying off any odor, due to decaying vegetable matter.

In order to properly filter the water it is necessary to feed to the raw water a small amount of alum solution. The carbonates present in the lake water decompose the alum into aluminum hydrate, an inert, flocular, sticky substance, and carbon dioxide, a gas which escapes from the water. The aluminum hydrate coagulates the impurities present in the water (an action similar to the clarifying of coffee by means of the white of an egg), gathering same together into comparatively large particles. These particles are retained on the filter bed, forming a blanket, which enmeshes and retains all foreign substances which are suspended in the water, including germs.

The alum solution must be fed to the raw water in exact proportion to the amount of water passing through the filter, and inasmuch as the pumping system is direct and therefore irregular, rising and falling with the increase and decrease of consumption, a very ingenious system was especially designed to meet this condition.

As above stated, the water flows from the lake by gravity to a sedimentation basin located below the filter-house floor. This basin communicates with the pump well by means of an adjustable sluice gate, which is opened just sufficiently to produce a difference in level between the water in the sedimentation basin and the water in the pump well of twelve inches, when the pumps work at their maximum rate of two million Imperial gallons per twenty-four hours. Whenever the speed of the pump decreases, the difference in the levels between the sedimentation basin and pump well also decreases, and this difference in levels is constant for a given pumpage, irrespective of any variation in the lake level.

The pump well and the sedimentation basin are connected each with a float tube provided with floats, which actuate a differential control mechanism, which control operates a swinging orifice in the orifice box. The orifice box is fed with alum solution from the solution tanks and the level of the solution in the orifice box is kept constant by means of a ball cock. It therefore can readily be seen that the variation in the difference of the level between sedimentation basin and pump well is in direct proportion to the head of the solution in the orifice box above the swinging orifice.

From the orifice box the solution discharges into a feed box, from which feed box the solution is piped to the various points of application. It has been found best practice to feed one portion of the solution to the entrance of the water into the sedimentation basin, another portion into the pump well, and a third portion directly into the suction of the pumps.

The accompanying photograph shows the general arrangement of the plant.

Each filter is also provided with a mercury indicator, showing at all times the amount of water passing through each filter when filtering, and the amount of water entering each filter when washing. Whenever the accumulation of impurities in one of the filters reaches such a point that the delivery of the filter is considerably decreased, this will at once be indicated by the mercury indicator, thus telling the operator when it is necessary to wash the filter. The main supply and discharge pipes are provided with pressure gauges to show the difference in pressure or loss through friction between inlet and outlet.

The plant was designed and built by the International Filter Company, Chicago, under the supervision of the Orillia Water, Light and Power Commission, Mr. W. K. Greenwood, B.A.Sc., Engineer.

Concreting in Cold Weather

As a number of things have interfered with contracting this season, notably the shortage of labor, many contractors not now informed on the requirements of cold weather concreting would no doubt appreciate knowing how they might profitably lengthen their contracting season.

Concrete work can be carried on successfully in cold weather. All that is necessary is to heat the sand and pebbles or broken stone and mixing water so that the concrete mixture will have a certain minimum temperature, then to place the concrete quickly and maintain the heat until early hardening has been completed. This does not mean that there are no limitations to the practicability of doing concrete work in cold weather, but that if a few simple precautions and protective measures are used, winter concrete work will be as successful as that done in warm weather.

Many contractors have found their working season profitaby lengthened by using these precautions and protective measures. This means that men and equipment can be kept profitably employed almost regardless of season. In this way the contractor can keep his efficient organization together. The resulting advantages are far greater than the seeming disadvantages, principal among which is that applying the necessary precautions slightly increases the cost of cold weather work. This, however, is usually offset by the builder's willingness to pay for the privilege of having the use of his building or structure earlier than would be possible if work were postponed until warm weather. The contractor, therefore, who decides to lengthen out his construction season will do well to keep the following in mind:

Remember that during the first few days following the placing of concrete alternate freezing and thawing at comparatively short intervals will damage it.

Remember, therefore, that it is necessary to so mix, place, and protect the concrete that early hardening will be complete before the work is exposed to freezing temperatures.

Remember that to do this:

1. Sand and pebbles or broken stone used must be free from frost or lumps of frozen material.
2. If these materials contain frost or frozen lumps, thaw them out before using.
3. As cement forms but a relatively small bulk of the materials in any batch of concrete, it need not be heated.
4. Mixing water should always be heated.

Remember that, although adding common salt to mixing water will prevent freezing of concrete that has not hardened, there is a limit to the quantity of salt which may be added if the final strength of the concrete is not to be affected. Salt simply lowers the freezing point of the mixing water; it does not supply what is most needed—heat and warmth. It delays, instead of hastens, the hardening of the concrete.

Remember that sand and pebbles or broken stone and mixing water must be heated so that the concrete when placed shall have a temperature of from 75 to 80 degrees.

Remember that some sands are injured by too much heat. The same applies to certain varieties of pebbles and broken stone. A temperature not exceeding 150 degrees Fahrenheit will generally prove most satisfactory.

Remember to place concrete immediately after mixing, so that none of the heat will be lost before placing in the forms.

Remember to warm metal forms and reinforcing before placing concrete. Be careful to remove ice and snow and frozen concrete remaining on the form from preceding work. Forms can be warmed by turning a jet of steam against them or by wetting with hot water.

Remember that even though materials have been heated and the concrete placed immediately after mixing it will lose much of its heat if not protected from low temperatures.

Remember, therefore, to protect the concrete immediately after placing. Canvas covering, sheathing, housing-in the work, or hay or straw properly applied, will furnish the required protection for some work. In addition to these means, small oil or coke burning stoves or salamanders may be used in enclosed structures.

Remember that temperatures which may not be low enough to freeze the concrete may, nevertheless, delay its hardening for a considerable time. Do not expect concrete placed when the temperature is low and remains low for some time afterward to be safe for use as soon as though placed during warmer weather.

Remember that if concreting is unavoidably delayed or interrupted the work should be covered until concreting is again begun.

Remember to cover and protect any sections of the work as soon as completed. In severe cold weather continue this protection for at least five days.

Remember that forms must not be removed from the concrete work too early. This applies to any concrete work, regardless of season, but is particularly important with work done during cold weather.

Remember that frozen concrete sometimes very closely resembles concrete that has thoroughly hardened. When frozen concrete is struck with a hammer it will often ring like properly hardened concrete. Before removing forms, examine the work carefully to see whether it has hardened or is simply frozen. To determine this, remove one board from some section of a form, pour hot water on the concrete or turn the flame of a plumber's blow-torch or a jet of steam under pressure against the concrete. If frozen, the heat will soften the concrete by thawing the water contained in it.

Remember that although concrete which freezes before early hardening has been completed may not be permanently injured, if after thawing out it is not again exposed to freezing until hardened, protecting the concrete against possibility of freezing is best.

The Portland Cement Association, 111 West Washington Street, Chicago, have just announced that they are distributing a booklet, "How to Do Concrete Work in Cold Weather." It is supplied free of charge.

Sewage Disposal Works at Moose Jaw, Sask.

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solved, and suspended solids and oxygen consumed in four hours at 20 degrees C.

The samples tested are collected at two-hour intervals in separate bottles during the twenty-four hours, preserved in an ice chest, and at the time of analysis mixed in proportion to the sewage flow.

The Element of Safety in the Construction and Improvement of Roads

In the last issue of the Contract Record, there was published a letter from a correspondent advocating greater measures of safety and protection on the highways of this province. From time to time articles dealing with this important subject have been printed in these pages, in which more efficient provisions of safety in the construction and improvement of roads were recommended. This problem is of such importance that further comment on it is not out of place, and in the light of many matters pointed out by our correspondent, we feel, not untimely. We therefore reprint from "Good Roads" parts of a recent article along this line:—

At a time well within the memory of most road builders, the element of safety commanded relatively little attention in road work. Neither in design nor in construction was a safe road kept in mind as the kind to be built, and little effort was made to eliminate danger points in existing roads.

The road builders of that time were not greatly at fault in their disregard of this factor in location and construction. The traffic over the roads was light; it consisted entirely of horse-drawn vehicles and pedestrians with an occasional horseback rider, and all of it, according to present standards at least, was slow moving traffic. Accidents, though not unknown, were infrequent, and generally resulted from a road surface out of repair or, often, from some cause not related to the character or condition of the highway. These traffic conditions were the ones for which roads had to be built, and as first cost was often—perhaps more often than now—the governing factor, sharp turns and excessive grades were the rule almost everywhere except in flat or rolling country.

As the automobide evolved from a curiosity to an everyday business and pleasure vehicle, from a clumsy, slow-going "horseless carriage" to a trim, powerful machine capable of express-train speed, the danger of obstructions to the view of the road ahead became more and more apparent. At present motor-driven vehicles are in the great majority on many country roads. They are driven at high speeds and in some sections where the roads carry an especially large number of pleasure cars, every pleasant Sunday or holiday exacts its toll of accidents.

It is doubtless a fact that most automobile accidents are caused by incompetent or reckless driving, but at the same time, dangerous roads are partially responsible. Many an accident would have been prevented in spite of poor or reckless driving had proper provisions been made for safety when the road was built. To put it in another way, it is now necessary to build roads as nearly "fool proof" as conditions and funds permit.

Dangerous Features

The most common dangers of the road are excessive grades, sharp curves, short sight lines and various combinations of these. The steep grade is perhaps the least dangerous, although it is something to be avoided for safety's sake as well as for the saving in power. There is occasionally a road upon which the summit of two intersecting grades is a source of danger because the drivers of two cars which happen to meet just at the top cannot see each other until just before they meet. Heavy grades are also dangerous because they increase the likelihood of serious results from unavoidable accidents to cars.

The sharp curve is ordinarily dangerous only to vehicles on the wrong side of the road or travelling at a comparatively high speed. But it is necessary to recognize that motor vehicles will be driven at fairly high speed and that the drivers will often take a chance and hug the inside of a curve whether the inside is to the right or to the left. At a curve there is added to the danger of collision that of leaving the road if the car is speeded beyond a certain limit.

Short sight lines are without doubt the greatest of the three dangers to which reference has been made. A sight line shortened by obstructions is most frequently encountered on curves, but is also common at intersections where, as a matter of fact, three sight lines have to be taken into account—one along the road ahead, and one each way along the intersecting road or railway. Assuming a roadway to be of sufficient width to allow two vehicles to pass safely, an obstructed view of the road ahead—like the sharp curve—would not be a menace to the safety of motorists or other users of the road if all drivers kept to the right and drove slowly enough so that they could stop within a very short distance. These conditions do not obtain, however, and it is necessary to consider the sight line very carefully.

Providing for Safety

The work of providing for the safety of traffic may be considered under two general classifications; first, in the design and construction of new roads, and second, in the relocation and reconstruction of existing roads.

In new work, the making of ample provisions for safety is very largely a matter of location. Grade, curvature, and, to a considerable extent, the sight line, generally can be adjusted to the requirements of safety when laying out the route, although special construction may sometimes have to be provided for when the location is fixed by topographical conditions or by the difficulty of securing rights of way. Probably no hard and fast rules can be laid down for limiting grade and curvature—both having to be determined with reference to the conditions obtaining on the particular road under consideration.

The grade will often be determined very largely by the available funds, and, of course, where a steep grade is unavoidable, especial effort should be made to avoid sharp turns and obstructions to view on the inside of the curves. The steep grade, in itself, is less dangerous than the sharp curve, and both are rendered safe if a sufficiently long sight is provided.

Minimum radius of curve, like maximum grade, must be determined with care, but, again like the matter of grade, it cannot be made the subject of a fixed rule. It must be decided upon in each case, giving due weight to grade, sight line, and a variety of other factors, both independent and inter dependent.

The sight line is by far the most important factor entering into the problem of building safe roads, for it can be made the most fruitful cause of accidents or the most effective safeguard. As indicated in the previous references to grade and curvature, what would

otherwise be dangerously high grades and sharp curves can be made safe by providing sufficiently long sight line. The problem of determining the necessary length of sight line is similar to that of fixing upon a maximum grade or that of finding the minimum radius of curvature in that it cannot be considered alone, but must be studied in connection with other factors, chief among them being grade and curvature. Indeed, these factors are so inherently inter-dependent that no intelligent discussion of any one of them can be undertaken unless the other two are assumed.

In the location of a new road the route should be carefully examined throughout its length with a view to so adjusting grade, alignment and sight line as to make the road safe for the traffic it will carry. Upon occasion reliance will have to be placed almost solely upon sight lines to accomplish the desired result, and there will be but few cases in which a long sight line will not provide an adequate safeguard.

It is most frequently in the work of improving existing roads, however, that the problem of providing for safety becomes pressing, for the great bulk of highway work at present consists of improving old roads rather than building new ones. For the reasons already outlined, many of the present roads were built with little or no regard to the now important consideration of safety and the frequency and seriousness of accidents make it essential to remedy the conditions that are contributing causes. Such remedial measures consist largely of widening roads at curves, banking curves sharp enough to require it, reducing grades where practicable, and removing obstructions in the sight line. These measures are, of course, the same as those taken in original construction, and, in general, are carried out in the same way.

Eliminating Dangerous Curves.

Widening the road on curves is one of the simplest of safety provisions, and has become standard practice in many sections both in new work and improvement. How much should be added to the width of a road at a given curve naturally depends largely upon local conditions. Both the paved portion and the outer shoulder should be widened, the latter to provide an added safeguard if a vehicle is forced off the pavement. Sometimes additional right of way has to be secured in order to widen the road, but even in such cases, the expenditure generally would be justified. An advantage of such construction at curves, apart from the greater safety secured, is that there is a tendency toward a better distribution of traffic over the width of the pavement.

Another method of safeguarding traffic at curves is the division of the road into two parts. This divides the traffic, as on such a curve only the most flagrant disregard of the rule of the road would make it possible for a driver to hug the inside when keeping to the right would necessitate taking the outside of the curve. Where this construction is used the width of each separate pavement should be somewhat greater than half the width of the pavement on tangents, unless the latter has a width exceeding about twenty feet.

Curves on roads used to any considerable extent by motor driven pleasure vehicles should be banked. The amount of superelevation will depend on the degree of curve and the speed of traffic, but it should never be great enough to be a serious hindrance to slow traffic or to standing vehicles. There is, however, one objection to the banked courve; it probably tempts the driver of an automobile to a speed greater than is safe.

Grade Reduction.

Reduction of grade is so generally undertaken for other reasons than safety that it needs little consideration. It is safe to assume that grades will be cut down about as much as possible, or practicable, to reduce the resistance to travel and that the matter will rarely come up merely as a safety measure.

Lengthening the sight line is doubtless the measure most generally adopted to remedy unsafe conditions. It is not only the most effective, but frequently is the only practicable expedient. The necessary length of sight line can no more be determined by a rule-of-thumb than can the other problems of safeguarding travel. But a sufficiently safe road will be provided if the sight line is made approximately equal to twice the distance in which it is possible to bring to a stop, without undue strain on the brakes or upon the skill of the driver, a car travelling at the greatest speed likely to be attained at the place under consideration. Fixing upon this speed may be a matter of some difficulty, since speed maniacs are everywhere, and an attempt to guard traffic from these exceptional cases would bring the cost to a prohibitive amount. It is sufficient to assume a maximum speed of, say, 40 or 45 miles an hour, which would cover all ordinary traffic and most of the cases of excessive speed since the meeting of two cars each going over 40 miles an hour at any particular curve would be infrequent.

Increasing the Sight Line.

The actual work of lengthening the sight line generally consists of either excavating the bank on the inside of the curve, or clearing the corresponding area of trees, underbrush or other obstructions. On country roads this usually can be done at a comparatively small cost. Where it would be necessary to excavate rock, the cost would generally be prohibitive, as it might also if lengthening the sight line necessitated cutting valuable timber. In such instances recourse can often be had to widening the road on the outside of the curve, for as a rule extra right of way can be secured on one side or the other. If the road runs through a rock cut or for some other reason is so located as to make securing additional width unduly expensive, reliance must be placed upon warning signs.

In actual work more and more attention is being paid to the matter of safety. In New York State work, for instance, the pavement proper is widened on curves and banked. In addition, the slopes of the inner banks at curves are cut back and cleared far enough back to materially lengthen the sight line. The standards of the New York Commission of Highways provide for banking a 16-foot pavement as follows: Curves up to 300 ft. radius, 10 ins.; 300 to 400 ft. radius, 9 ins.; 400 to 550 ft. radius, 8 ins.; 550 to 800 ft. radius, 7 ins.; 800 to 2,000 ft. radius, 6 ins. Where curves are banked in this manner, the road surface is made a plane intersecting the plane of the theoretical grade at the centre line of the pavement.

It is particularly gratifying to observe that highway departments and roadway authorities are doing more than ever in promulgating the principles of "safety first." It is gradually being realized that dangerous highways are relics of a by-gone day and in very many localities very efficient measures are being taken to re-align roads, decrease grades, eliminate sharp curves, remove grade crossings or otherwise dangerous and unsafe obstacles.

Placing Concrete by Pneumatic Methods

The means used in mixing, conveying and depositing concrete by compressed air and live steam

By J. L. Springer*

A NEW method of transporting concrete from the mixer to the point of use has lately come into use and has been pretty thoroughly tried out on several important jobs. Compressed air is employed to do the conveying. But the procedure is not so simple that it can be performed without due regard to certain characteristics of concrete and the conveying tube. When these are understood and provided for, there is ordinarily no trouble.

The pressure of the compressed air is what carries the concrete along. The first thing to consider is the necessity of getting the heavy weight started. A little consideration will perhaps prepare one to understand that in the new procedure a very strong impulse is employed at the very start. That is to say, with a pipe transmission line 8 inches in diameter and a half-yard batch to send through, the initial pressure will ordinarily be about 85 pounds per square inch. This gets the heavy mass under way. After a very short time and with the concrete moving along, the pressure will be kept at about 35 or 40 pounds. A batch of concrete can be shot through the pipe at the rate of 50 feet per second—a speed of thirty-odd miles per hour. Compressed-air transmission of concrete may be used with pipe lines ranging from 50 to 3,000 feet long. The diameter of 8 inches seems to be about right to suit present methods.

The pipe will not necessarily be cut up by the concrete. In the first place, the concrete is not permitted to quite fill the interior. The pipe should have a smooth interior surface. Ordinary lap-welded steel pipe with flanged joints is quite suitable. Bends may be made, provided they are on a 36-inch radius. Either bent steel tubes may be employed for elbows or built-up elbows consisting of cast-iron sections of 22½ degrees curvature each. The pipe line may run up and down, to right and left—only there must be, of course, some limit to the number and frequency of the curves. Riveted pipe is unsuitable, as the rivet heads present obstructions which the concrete would proceed to wear down. Pipe with smooth interior stands up well.

The Mixing Process.

With this system, the ordinary mixer is eliminated entirely and a kind of pressure tank substituted. The mixing, it appears, is not completed in the tank, but after the materials have actually started for their destination. It is thought that it is pretty well completed, though, in the first twenty or thirty feet of the pipe line. The mixing process probably continues to a greater or less extent throughout the whole journey.

When the concrete arrives at its destination, it possesses a good forward motion. This suffices to tamp it well into the crevices and to consolidate the concrete itself. A short space is allowed between the end of the pipe and the point of deposit. This interval permits the compressed air to expand to atmospheric tension. It is understood that concrete alone is packed into the mass. As the concrete comes with a rush, it is not difficult to place it overhead or pretty much anywhere.

Let us now consider the mixing tank. This is not a complicated affair at all. There are no turning parts to effect mixing. The activity of the compressed air is depended upon for that purpose. There is at the top a small hopper which is not so much a container as a guide. There is a down-swinging door which forms its bottom. Above the hopper is a real hopper which forms no part of the device, but is simply a rough chamber in which the requisite quantities of rock, sand and cement are placed with no effort to mix them. When the mixer is not under pressure the door may be open, giving access to the whole interior of the mixer. The materials are dropped in. They will settle down at once, permissibly filling the mixer up to the bottom of the chamber in which the door moves up and down and which may be termed the door-chamber. At the bottom, the mixer converges to a tube which bends and runs off horizontally. When the materials have been dropped into the mixer from above, they will in part naturally settle down into this bend. Back of the bend, right at its turn, provision is made for the controlled entrance of compressed air. There is also provision for compressed air entering above the charge of materials and below the door when that is in closed position. The closing of the door is effected by compressed air operating against a small piston in a cylinder. This air is transmitted by a special tube of small diameter. A second small diameter tube connects the door-chamber with a suitable pressure gauge, which enables the actual pressure conditions in the mixer to be known at any moment.

We will now suppose the materials to have been dropped into the mixer and the proper amount of water to have been fed in with a hose, everything having gone in through the one opening. The cock is turned which admits compressed air to the piston cylinder and the door is thus closed. A heavy pressure is now set free at the bend in the elbow forming the bottom of the mixer. The effect is partly to start some of the concrete horizontally along the conveying tube, but partly to send a stream of air up against the main load of materials. This stream will force its way through and there will be evidence of a pressure above the materials in a movement of the indicator on the gauge connected with the door-chamber. Assuming 85 pounds for the starting movement and assuming that this movement was quickly checked, the gauge will show perhaps 12 or 13 pounds of pressure. Pressure air will now be admitted directly into the door-chamber, but at a much less pressure than that employed in effecting a start. Thirty-five or forty pounds is about right. The gauge will be carefully watched by the operator and the cock manipulated to maintain the pressure at just about this stage. If it is allowed to drop much below, the concrete will be likely to choke the conveying tube; if the pressure is permitted to rise much higher, there will be an unnecessary waste of pressure air. The operator's duty is, from now on, a very simple one, and consists principally in keeping his eye on the gauge and managing the pressure air at a pretty constant pressure.

It seems that the pressure required to convey concrete along the pipe is the same whether the pipe is

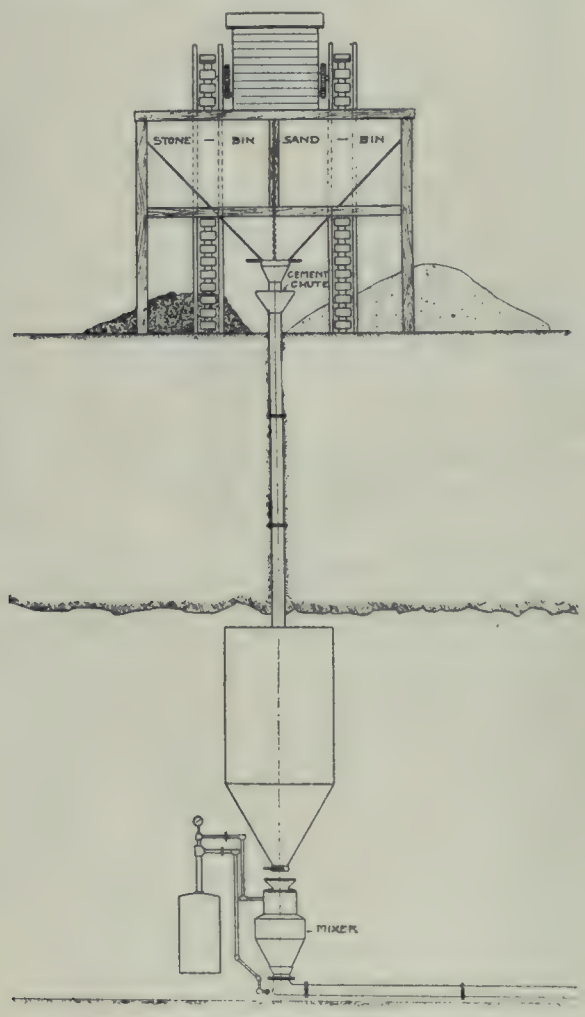
*Adapted from an article in Cement World.

long or short. Doubtless, when considerable experience is gotten with other diameters of conveying tubes, it will be found that the required pressure will vary with the diameter.

Amount of Water Immaterial.

The amount of water appears to play no substantial part. Dry concrete can, in fact, be conveyed. With 8-inch tubes and elbows on 36-inch radii, there appears to be no difficulty in using concrete in which the coarse aggregate has a maximum diameter of two inches. Occasional larger pieces give no trouble, ordinarily. Uniformity in size of the coarse aggregate seems to promote ease of conveying, whether the material be crushed stone or gravel. As to the fine aggregate—the less loam and other material of a slick character, the better the transmission.

The mixers are of two sizes—those receiving ¼ cubic yard of materials, and those receiving ½ cubic yard. Naturally, the amount of pressure air required will vary with the distance of transmission. For the larger mixer, 1,000 feet is the limit of economical movement. A compressor capable of compressing 1,200 cubic feet of free air per minute will, it is said, supply enough pressure air to convey 8 cubic yards of concrete per hour. The same compressor will handle fifty cubic yards—six times as much—in the same time, if the pipe line is cut down to 100 feet. A smaller compressor will not only have a less maximum radius of action, but will within that radius operate less economically. Thus, a compressor which compresses 600 cubic feet of free air per minute—one-half the capacity of the larger one cited—will have a limit of about 400 feet to its transmitting capacity; and at this distance, it will handle only one-third the amount of concrete as compared with the bigger machine. At any rate, the general law appears to favor the larger compressor. Whatever exceptions there are, seem to correspond with rather short distances of transmission. At such distances, it may be that the smaller machine will work more advantageously. It is interesting to note that the diameter of the pipe line affects the amount of air required. Other things being equal, the smaller the tube, the less pressure air is needed. Now the necessary diameter of the tube in turn depends upon the size of the coarse aggregate—big aggregate requires big diameter of pipe.



Arrangement of a compressed air mixing apparatus.

Where the distances of transmission will undergo considerable changes, it may be well to install two compressors, one of, say, 800 cubic feet capacity per minute and the other of, say, 450 cubic feet. The smaller machine may then be employed on the short transmissions and the larger machine or the two combined on the long distances.

Where only one compressor is to be installed, the 600-foot machine will be perhaps the minimum size for effective work with the ½-yard mixer. With the ¼-yard mixer, compressors as small as the 350-foot size may be used. In the foregoing, the actual compressor capacities—and not the theoretical ones—are to be assumed.

Adapted for Limited Spaces.

A little consideration will make it understandable that the pneumatic method is particularly suited to tunnel and sewer work. The small amount of space required to provide for transmission is an especial advantage. We have merely to provide for a pipe line. We may choose the location of the mixing. Of course, it is advisable to lessen the distance of transmission because such reduction means economy in pressure air. On the other hand, we may, if conditions require it, put the mixing arrangements outside the tunnel or sewer. Thus, the mixer may be placed overhead the excavation, now at one point, and now at another. The transmission tube may be put down a bore hole and then connected with a horizontal line of pipe. Or, if there is room below and it is otherwise convenient, the materials may be dropped down the small vertical hole.

This latter procedure was found suitable in concreting a big sewer in a large city. Here the excavation lay some 80 feet below the general surface. A station for the assembling of batches of dry materials would be selected on the surface, and a hole 8 or 10 inches in diameter would be put down to the sewer. At the surface, suitable pits for the feet of elevators were arranged for the coarse and the fine aggregates. These materials were dumped in their respective pits and then raised by the elevators and discharged into bins. From the bins, the two materials could be discharged under control into a hopper located over the vertical hole. Below, in the sewer, a second hopper was set up above the mixer. This hopper served as an intermediate reservoir between the hopper at the surface and the mixer below, and prevented the latter from unexpected service. From the mixer station below, the transmission could be effected horizontally for 950 feet in two directions, making a total of 1,000 feet for one surface station.

This sewer has a diameter of perhaps 15 feet and in transverse section has the outline of an inverted U. It is some 18,000 feet in length. The concrete em-

ployed is understood to have been made on the formula 1:3:5. The stone was of the two-inch size. The average thickness of the lining is perhaps 18 inches. Ordinary steel pipe was used for the straight sections. It stood up well under the flow of material within it. It is understood that it was found possible to transmit some 18,000 or 20,000 cubic yards of concrete without necessitating a renewal of the pipe. The diameter employed was eight inches inside. The concreting of the side walls and overhead arch was done with the aid of collapsible steel forms with which 40 feet of sewer could be lined at a setting. With such forms it is ordinarily possible to be concreting with some, while others are being moved to new positions and there prepared for the concrete. Accordingly, with five sets, actual concreting could go along at a clipping pace. However, this would make a heavy demand upon the means of transmitting the concrete. Nineteen of the 40-foot sections were concreted in fourteen ten-hour shifts. As the concrete was put on to the substantial thickness of 18 inches already mentioned, there was a first rate test of the pneumatic system in keeping forms supplied.

Against the cost of transmission should be set the economy arising out of the automatic tamping. Ordinary recesses and crevices will be filled as a matter of course.

The engineers of a United States railway devised a special car to be used in connection with pneumatic mixing and placing of concrete in the lining of a tunnel on their line.

A Special Car for Concreting

The tunnel is 1½ miles long. The strata through which it passes consist in part of slate and shale, and in part of badly seamed and broken sandstone. It was deemed advisable to line the tunnel without delay. It was also desired to place the 50,000 or 60,000 cubic yards of lining without putting a stop to the passage of trains.

With a stationary mixer at either portal, the average haul to be accomplished by a concrete car would have been about three-eighths of a mile. This would have meant delay and expense. A compact, self-propelled mixer was the outcome of the conditions to be met.

A steel car 40 feet long, 10.38 feet wide and standing 17.75 feet above the rails, was constructed. The adoption of steel probably resulted in a much lighter car than if wood had been selected. Naturally, the sand, stone and water are carried at some height above the rails, so that strength of construction is an essential. Amidships of the car, a chamber open on either side is provided for the mixer and the charging skip. This chamber occupies what for convenience may be called the lower storey of the car. Immediately overhead is placed the water compartment, formed by dividing the upper storey, transversely, by steel bulkheads. An X-brace on either side provides for resistance to the hydraulic pressure. The capacity of the tank is 1,850 gallons.

To the front and to the back of the tank are placed the stone and sand bins. These are provided with inclined bottoms sloping down towards the centre of the car and extending down into the first storey. Suitable chutes extending into the open chamber on one side of the car provide for discharge into the charging skip. The mixer is located on the same level on the other side of the car.

The motive power is supplied by a gasoline engine. This was located beneath the sloping floor of the sand bin. At the other end of the car, beneath the stone bin, is placed an air receiver, a tank used to contain a supply of compressed air. Its capacity is 96 cubic feet. There was a certain amount of free space here beneath the stone bin. This provides dry storage room for cement in bags.

When the charging skip is standing on the floor ready to receive the materials, its top is 15 inches above the floor level. Guide rails provide for its movement up and across the car to a position over the mixer. This movement is effected by compressed air operating in a cylinder 9¼ inches in diameter. The guide rails are T-bars, 40 pounds to the yard. The skip is provided with a discharge gate which is tripped automatically by a guide rail.

Arrangement of Discharge Pipe.

The mixer has a capacity of about 2.5 cubic yard, corresponding to two bags of cement. At its bottom is an 8-inch discharge pipe which carries the concrete horizontally and then vertically to a point near the top of the rear of the car. At this point, the discharge pipe divides into two branches. One branch is used when the concrete is to be shot into the foundation or side wall; the other, when its destination is the arch. This arrangement is a patented device. It includes a sliding plate, by whose means the concrete may be controlled in its movement into either branch.

Along one side of the car are arranged running boards two feet wide. These may be folded up against the side of the car when not in use. They provide a footway for the men going from one part of the car to another, particularly when moving cement from storage to mixing compartment.

The gasoline engine which supplies the power for locomotion is a 6-cylinder, 4-cycle, T-head machine, and has a horsepower rating of 200 when running at 350 r.p.m. The speed of the engine may be throttled down to 125 r.p.m. This motor with its frame constitutes an integral part of the car, forming, in fact, one of the trucks. Power is transmitted by a chain to one of the axles. A specially designed friction clutch provides for control. The car may be moved with considerable rapidity, a speed as high as 25 miles per hour having been attained.

When the car was in need of more material, it was run out of the tunnel to a special loading trestle. Arrived beneath this trestle, any one or all of the four items—water, sand, stone, cement—could be delivered by gravity. The cement went on board in bags along a chute. Undercut gates provided for the delivery of sand and stone.

The compressed air supply for the car was obtained from a 4-inch air main running through the tunnel. By means of a 3-inch hose, 12 yards long, the air receiver on the first car could be supplied from the air main.

When this apparatus was first put into actual commission, the men operating it were naturally not expert at handling it to the best advantage. Nevertheless, in the first week (6 days), 261 cubic yards were placed by its means. During the fourth week after this, about 3½ times the quantity (928 cubic yards) was placed. A record of 201 cubic yards was made in a single day. The fact that the tunnel was being used by trains while the concreting was going on complicates matters and obscures to some extent the actual performance.

The storage trestle has a track beneath it for the

locomotive mixer car. There is another track over its deck. The 27 bins of the trestle provide storage for 324 cubic yards of material. As five loaded cars may stand on the deck track, the available storage is increased by this means to a total of more than 500 cubic yards.

The gasoline mixer car is preferable in tunnel work to a locomotive operated by steam because of the elimination of smoke. Of course, electric motors would cover this same point.

The inventor of the pneumatic system used here and elsewhere on long and short transmission lines is Mr. J. H. Graham.

Placing Concrete with Live Steam

Another recent system in transmitting and placing concrete is that which depends upon the pressure of live steam. This method deals with a further thing. That is to say, the fresh concrete is warmed up distinctly in the process. Now the setting of concrete is largely a chemical process, so that when one considers how heat promotes most chemical reaction he is prepared to learn that the claim is made for the steam process of conveying that it is distinctly beneficial to the quality of the resulting concrete.

Steam is employed to drive concrete through a pipe line and so effect the placing. The concrete comes out at the end with a rush so that it is possible, if desired, to discharge the concrete in a strong jet. Off hand, one might expect this system to be rather expensive. Actual experience has shown, however, that for a distance between 300 and 400 feet the cost for mixing and placing, including labor, can be done for 26 to 32 cents per cubic yard. Fuel for the steam plant is counted in with this cost.

Concrete can be conveyed by this method through 2-inch and 3-inch pipe lines, provided the coarse aggregate in the one case is limited to 1-inch size and in the other to 1½-inch. In using such small pipe, it is very advisable that no large pieces of stone or other hard material get into the concrete, even though these exceptional pieces should be few in number. There should be absolutely none of them. Crushed stone or rock should not go into the concrete unless it has actually gone through the meshes of a rigid screen having the proper size of openings.

There seems to be no difficulty in forcing the concrete along, nor is there any undue wear of the interior surface when the special tubing designed for the purpose is employed. At first, rubber tubing was employed. But this seems now to be not so well adapted, the possible cause being a deterioration in the grade of rubber obtainable at a reasonable price. A special coating is now applied to the interior of the pipe. The concrete slips along through this tubing without difficulty, so the writer understands.

Protection Against Loss of Temperature.

The steam in contact with the concrete must be protected against much loss of temperature. Otherwise, we are likely to get more or less condensation with the consequent loss of pressure. Accordingly, it is not enough to use simple, bare pipes, especially where the transmission is for a considerable distance. This matter is being taken care of by the inventor of the system in the following way. The coated pipe is covered with a thick envelope of magnesia, or other non-conductor of heat, and a spiral sheet tubing put about the magnesia. This exterior metal covering may be galvanized. Each length—measuring, say, 23 feet—is then provided with three chairs. These are devices which provide a means of lifting the pipe by hand from above and a means of holding it a little above the ground when at rest. They also provide a simple means of securing mutual agreement in alignment of a group of pipe lengths. The joints are made by using a sleeve which goes over both ends and which may be secured quickly in place with the use of a bar and without the use of a wrench. A U-bolt forms part of the device. Ordinarily, the coupling arrangements are sufficiently flexible to permit a 15-degree variation in alignment from pipe length to pipe length.

Preferably, super-heated steam is used. Often it will be unnecessary to use elaborate methods of heating the steam. The simple procedure of passing the pipes back and forth at a point where they can be subjected to gases of combustion will frequently be all that is necessary.

The operation of the mixing and propelling apparatus is about as follows: All materials, including water, are put into the mixing chamber and the door closed. Steam is then turned on with the result that a paddle device is turned which mechanically performs the mixing. Steam is admitted into the mixing chamber during the mixing process. When the materials have been sufficiently churned, steam is admitted into another compartment, the atomizing chamber. The steam admitted presses out through the discharge line, clearing the tube preparatory to the coming of the freshly mixed concrete and heating it up as well. The steam pressures in the mixing and atomizing chambers are different, at least at this stage. In the mixing chamber, the steam admitted will have a pressure of perhaps 80 pounds per square inch, and a temperature corresponding to 50 degrees superheat. In the atomizing chamber, on the contrary, the steam pressure will be markedly less, say 30 pounds per square inch. This steam is also superheated. Accordingly, when the valve connecting the two chambers is opened, the superior pressure in the one operates to drive the concrete into the other, assisted by the action of the paddle device. The concrete will now be atomized—that is, divided into small particles—and forced into the transmission line. The pressure of the steam will in the meantime probably have become about 40 pounds per square inch. When discharged, the concrete is in the form of a kind of spray which consolidates when placed.

It is very necessary that the steam which is doing the propelling work through the transmission line shall not condense and so lose its power of exerting pressure. This has already been suggested when mentioning the provisions against the escape of heat. The superheating is a further provision with the same object in view.

Particular Examples.

The steam method of placing concrete was employed on some Mississippi levee work. The bank had a slope of 1 on 2, and it was desired to protect it by a covering of concrete. The concrete was put on two inches thick in squares 25 feet on a side. About half of such a square extended above and half below the high water level. The mixture employed had proportions given by the formula 1:3:2. A coating was added to the bank for a distance along the river of perhaps 1,200 feet. No reinforcing was employed. No provision was made for securing the concrete to the sloping bank other than what would naturally occur.

Recently, the steam method was used in connec-

tion with the relining of an old tunnel half a mile long. The tunnel penetrates soft material and was originally protected against collapse by a timber lining. Thirty years ago a second lining was put in inside the original one. This consisted of semi-vitrified brick. The space between the two linings was not thoroughly packed. A good deal of water pressure developed back of the brick lining, which resulted in constant leakage and a good deal of freezing into ice in the winter. The brick lining suffered a great deal because of the activities to which it was subjected. In short, the lining became very unreliable, especially in the arch. It was doubtful whether this brick lining could be very well replaced because of the character of the strata through which the tunnel passed. The addition of another lining within the old would have reduced the bore of the tunnel too much. It was decided to add a concrete coating by means of the steam atomizer.

Special Equipment.

It was desirable to perform the work without interrupting the use of the tunnel for traffic. A construction train was provided which consisted of a locomotive, caboose and three intervening cars. Next the locomotive was placed a flat car, which accommodated the mixer on its forward end, where it could be conveniently served with steam. By means of a reducing valve steam was supplied at 90 pounds.. Materials for the concrete were stored on the remainder of the car. A second flat car came next. It was rigged to facilitate the actual application of the concrete to the brickwork of the old lining. Here a platform 20 feet long was arranged 4 feet above the car floor. On the platform a track provided for the movement back and forth of a carriage carrying the discharge nozzle. The carriage could be moved 10 feet. The nozzle consisted of a piece of wrought iron pipe. To it was attached a piece of reinforced rubber hose, which connected at its other end with the main discharge line running from the mixer, which was laid along one side of the car. The nozzle was arranged to rotate on a horizontal axis lying in the vertical plane passing through the longitudinal centre line of the car. By these means, a considerable arc could be commanded with every position of the carriage. As the carriage itself could be moved 10 feet horizontally, a segment of a band 10 feet long could be dealt with without moving the train. The rotation of the framework to which the nozzle was attached was effected by a small steam engine. A windlass and rope operated by hand provided for the carriage movement. And the locomotive shifted the whole outfit. With this equipment, a strip of concrete 262 feet long and 11 feet wide was placed in six hours. The amount of cement consumed was 35 bags, and the concrete mixture corresponded to the formula 1:3:2. The entire job was carried through in 41 days at a total cost of $4,600. Of this, $1,700 went for rental of the machine and for expert supervision. The remainder was expended on labor, repairs, materials, the work train and expense of plant.

The way the concrete behaves at the beginning of its application is curious. The sand blows away for a time—until enough cement has been applied to secure its adhesion. Then the pebbles refuse to stay until sand and cement have prepared a sufficient thickness of mortar. However, it is judged that even the sand and pebbles that bounce off at the beginning perform a very useful service by pounding the first layer very thoroughly onto the surface to which it is desired to attach the layer of concrete.

A similar job to that of coating this old brick lining was carried out not long ago in connection with an old canal beneath which were two stone-lined water conduits which supplied a big flour mill. The tunnels were about 5 feet high. So ancient was the lining that the mortar had pretty well disappeared from the crevices between the stones.. The job of filling the spaces and making a smooth coating with concrete would have been rather difficult by ordinary methods. The atomizer proved equal to the task, however. The first operation was to clean the irregular surface by means of a jet of steam and hot water. This the atomizer supplied. The concrete was then applied by means of a sprayed stream. Very small pebbles were employed here for the coarse aggregate, and performed the admirable function of packing the concrete into the crevices.

Improvement in Building Situation

Building operations in many cities in different parts of the Dominion appear to have picked up considerably during the month of August, and while in some cases the building business was very slack during the previous seven months, last month's more active operations have helped to some extent to bring up the monthly average. This is especially the case in Vancouver, where we find that this year the permits for August, numbering 36, are valued at $625,879, as compared with 50 in 1915, at a value of $55,320. The total for the first eight months of the year, however, is $1,216,394, the permits numbering 269, as compared with $1,293,351 last year, when 475 permits were issued. The building work during August was as follows: Repairs and alterations, $15,100; dwelling houses, $800; factories and warehouses, $25,050; offices and stores, $584,929.

An Attractive Business Opportunity

The Art Stone Company, of Waynesboro, Pa., manufacturers of high-class concrete specialties, are making a special offer of exclusive manufacturing control in Canada on their Artisto concrete methods for making the following:—High class concrete, concrete marble, Scagliola and Marezzo marble, decorative concrete plaster work, cemetery work, lawn and garden furniture, stucco, brick and block facings, vases, porch work, composition flooring, marble lumber trim, waterproofings, matrix mold process, granite work, onyx and porphyry imitations, interior and exterior decorative work, concrete finishes, surfaces, textures, granite facings, etc. It is claimed that manufacturing can be done in your office or basement; no machinery required; profitable decorative lines, and an all the year round business. Builders, contractors and construction companies, with these art marble and sanitary flooring processes, can finish a hall, vestibule, bath room or fire place as cheaply as in hard wood, and add distinctive character to the entire job.

It is estimated that $750,000 is being spent this year on county road construction in the province of Ontario. This is slightly under the amount for last year, when the expenditure was about $800,000. On maintenance and repair work the outlay will be in the region of $200,000, which is considerably ahead of last year. The province contributes 40 per cent. towards the construction expense and 20 per cent. to maintenance.

New Machine for Rock Tunneling

A new appliance for rock-tunneling has recently been developed for subway excavation in New York City. The machine operates by means of pneumatic hammers fitted with chisels which turn on a longitudinal axis and chip the rock in a series of concentric rings. All operations are automatically controlled and the success of the machine depends on the relation between the force of the blow and the character of the rock, the blow delivered being proportional to the hardness of the rock to be cut.

The hammers are carried on a revolving head, comprising a hub with four arms at right angles, two arms bearing three hammers apiece, and the other two carrying four hammers each. The shaft which carries and rotates the head, is 12 inches in diameter and 14 feet long. The head is revolved and the hammers are operated by pneumatic power. The action of the rotating chisels evidently cuts the rock in a series of concentric circles.

The machine is carried on a two-wheeled main truck at the rear and a two-wheeled guide truck at the front, resting on a light standard gauge track. The two halves are separated, the front half, which serves the revolving head being moved forward one inch every revolution and after it has advanced two or three feet, the rear is brought up by means of gearing.

A compressed air engine on the carriage furnishes the power for rotating the head and manipulating the machine. The hammers are 12 inches long and weigh 32 pounds, and strike a chisel holder in which the chisel is firmly fixed. The chisels are made of 1½-in. square steel and have a movement not exceeding ½ in.

There is a distinct relation between the character of the cutting and action of the hammers. The supply of air to any single hammer depends entirely upon the demand, the control being effected by the bearing pressure of the tool against the rock. More air is supplied if the rock is harder. When a chisel does not bear against the rock, the hammer does not operate, and if it happened that the rock is sufficiently soft, the air supply is cut off and the rock is sheared off by the rotation of the head. This control is automatically arranged.

A spray of air and water over the rock face keeps practically all of the dust down. Spoil is elevated by two scoops carried on the rotating head to a belt conveyor that discharges at the rear into muck cars. The cylinders are lubricated by oil carried in with the air.

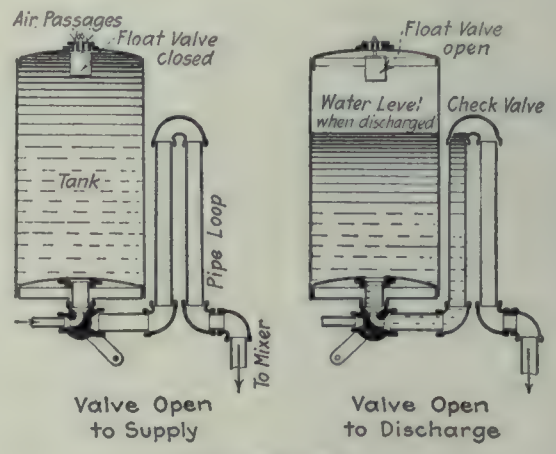
A test run showed an average progress of 7.6 in. per hour for a running time of four hours, and 9 feet has been drilled in 24 hours running.

Prominent B. C. Contractor Passes Away

Citizens of Vancouver, B. C., learned with much regret of the death of James Ironside, a pioneer resident, and one of the prominent contractors of the province, who passed away at the General Hospital on August 27th, following a severe attack of heart trouble. The funeral was delayed until the following Thursday to permit the attendance of three brothers of the deceased—Messrs. E. and L. Ironside, of Winnipeg, and Mr. Alex. Ironside, of Orillia, Ont. The late Mr. Ironside came to Vancouver over thirty years ago, and for eighteen years had been a member of the well-known contracting firm of Ironside, Rennie & Campbell, which carried out many important works in all sections of the province. Mr. Ironside, who was looked upon as one of the shrewdest men in his line of business in Western Canada, was 54 years of age and unmarried. He was born on a farm near London, Ont.

Automatic Water Feed for Concrete Mixers

The sketches shown herewith illustrate a new device recently put on the market for automatically delivering water to a concrete mixer. A three-way cock at the bottom of the tank opens it to the supply or discharge pipes or closes it off entirely. When the valve is open to the supply line, the water will enter the tank and a float valve at the top closes automatically when it is full. On the discharge side there is a U-shaped loop of pipe fitted with swivel joints and the amount of water can be regulated by shifting this loop to different angles, the amount discharged being the water between the top of the tank and the top of the loop. This is a minimum when the loop is vertical and a maximum when it is horizontal.



Automatic Water Feeder.

Mainly Constructional

East and West—From Coast to Coast

Building permits issued in St. Catharines, Ont., for the month of August totalled the sum of $91,000.

The Toronto Lime & Plaster Company will build a plant at Teeswater, Ont., to cost some $35,000, for the production of lime.

The paving work in Moncton, N.B., being carried out by the Warren Bitulithic Paving Company, was recently held up for a short time owing to shortage of cement.

The Mountain Hospital, for which the citizens of Hamilton, Ont., voted $200,000 in debentures to cover the cost of construction and site, will be completed before the end of the year. Frid Brothers, the contractors, soy they are held up by lack of material.

It is rumored that the Hanover Cement Company is taking options on several farms on the Teeswater Road between Walkerton and Enniskillen, Ont. This is taken to mean that the two sub ends of the C. P. R. will be linked up in the near

future and the lime rock which is to be had in abundance in that vicinity shipped to Hanover for cement making.

A press recently installed by the Dennis Wire & Iron Works in their London, Ont., plant, is said to be the largest of its kind in Canada, being 30,000 pounds in weight and used for forming steel lockers.

Counsel for bondholders and liquidator for the B. C. Portland Cement plant, before Mr. Justice Morrison in chambers, have argued for a 60-day extension for further attempt to adjust the company's involved finances.

Building permits issued at Welland, Ont., for the month of August this year total $25,648, as compared with $12,147 for August, 1915. The total for the first eight months this year is $146,218; for the corresponding period last year it was $126,054.

Building permits were issued in Galt, Ont., during the month of August numbering 17, at a value of $57,885. The permits issued up to the end of August this year total $196,-840, as compared with $104,775 during the corresponding period in 1915.

Rumors state that the completion of the parliament buildings at Winnipeg, Man., may be deferred until after the war, the government being strongly impressed with the fact that the construction will be very expensive according to present designs.

Meating Epps Company, Limited, have been incorporated with a capital of $20,000, head office St. George, N.B., and will take over as a going concern the granite manufacturing business at present carried on by the firm of Epps Dodds & Company.

During the month of August building permits were issued in Medicine Hat, Alta., to the value of $23,090, while in August, 1915, there were no permits issued at all. The 1916 total to the end of August is $367,190, as compared with $53,260 during the corresponding period last year.

The parliamentary committee, in charge of the rebuilding of the Dominion Parliament Buildings, have given directions that the stone which has been removed from the demolished walls shall be utilized as much as possible in the construction work, and that the heating plant shall be made use of.

The building permits issued in London, Ont., for the month of August numbered 105, and totalled $107,985, as compared with 118 permits last August for a total of $81,280. For the first eight months of the year, the permits total $692,715, as compared with $955,060 for the same period in 1915.

Following the defeat of his motion that the Peter Lyall & Sons Company be settled with for the work already done and that public tenders be called for the reconstruction of the Dominion Parliament buildings, Hon. R. Lemieux has resigned from the joint parliamentary committee in charge of this work.

During the month of August, 1916, there were 181 building permits issued in Montreal, at a value of $601,340, while for the same month last year there were 120, valued at $309,-763. For the first eight months of the year there were 1,352 permits issued, value $3,581,554, as compared with 1,438 during the corresponding period last year, value $4,161,362.

During the first eight months of the year 779 building permits were issued in the city of Winnipeg, representing a value of $1,936,450, as compared with 1,015 during the corresponding period last year, valued at $1,431,100. The permits for the month of August numbered 109, at a value of $163,450, compared with 95 the same month last year, valued at $151,600.

Twenty-two million gallons of water are pumped every twenty-four hours for the city of Ottawa, with a population of approximately 100,000. This, in the opinion of the Commissioner of Works, is nearly twice as much as should be necessary. Leaks in the mains are considered responsible for much of the wastage, while a great deal of it must also be due to unnecessary household wastes and similar causes.

To eliminate patronage in the employment of labor and purchase of materials for the reconstruction of the Dominion Parliament Buildings, a non-partisan board has been appointed composed of Mr. J. B. Hunter, Deputy Minister of Public Works; D. Ewart, Dominion Consulting Architect, who has been very many years in the public service; and Messrs. John A. Pearson and J. O. Marchand, the two architects who are to prepare all calls for tenders.

For the purpose of manufacturing sand brick by a new process, an invention of John T. Jackson, of Toronto, the Dominion Building Products, Limited, has been organized, with Dr. David D. Williams, also of Toronto, as president. The headquarters of the concern will be at Galt, where the erection of a plant will be commenced in a short time. Other plants will be established at Toronto, Sarnia, Owen Sound, Sudbury and Picton. Each plant will have a capacity of 190,000 bricks per day.

On September 1st with due ceremony H.R.H. the Duke of Connaught laid the corner stone of the new Dominion Parliament Buildings at Ottawa, the same one which 56 years ago his brother, the late King Edward, who was then Prince of Wales, tapped into place in the old building. The Governor-General was received by Sir Robert Borden and Hon. Robert Rogers, Minister of Public Works, both of whom delivered short addresses. The old documents, coins, papers, etc., as well as a new lot, were placed in the niche before the stone was laid.

Personals

Lieut. Norman Saware, of the Canadian Pioneers, has been decorated with the Military Cross by the King.

Lieut. Clement Saye, secretary-treasurer of the Northern Electric Company, has joined the 245th Battalion Canadian Grenadier Guards, now being organized in Montreal.

C. P. VanNorman, resident engineer, Toronto and York Radial Railway, Toronto, is attached to the 127th Battalion (York Rangers), with the rank of lieutenant, and is stationed in England.

Lieut.-Col. H. N. Ruttan, M. Can. Soc. C. E., consulting engineer for the city of Winnipeg, and formerly city engineer, who has been for some time district officer commanding at Winnipeg, has been promoted to brigadier general.

Obituary

Mr. James Brady, pioneer mining and civil engineer, and one of the best known residents of the Columbia Valley, passed away recently at Wilmer, B.C.

Mr. H. L. Williams, one of the oldest and best known citizens of Leamington, Ont., who for many years was engaged in the building trade, recently passed away at the age of 84.

Gunner Thos. L. Goldie, of the 16th Battery, C.F.A., died from infective jaundice in the Western General Hospital, Manchester, England, on August 28. Gunner Goldie was born in Guelph, Ont., 34 years ago, being the son of the late Mayor Thos. Goldie of that city. He spent some time prospecting in Northern Ontario and was with several surveying parties. Previous to his enlisting at Guelph, he was assistant city engineer at Regina, Sask., to City Engineer Frank McArthur, now city engineer of Guelph.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Hull, Que.
The City Council propose to construct a sewer and watermain on Scott Street, at an approximate cost of $8,000. Engineer, J. Laforest.

Jeannettes Creek, Ont.
Tenders on pumping apparatus required in drainage construction are being received by Oborn & Ellis, 22 College Street, Toronto. Estimated cost, $3,000.

Kitchener, Ont.
Plans of a waterworks system to be constructed for the City Council have been approved by the Provincial Board of Health. Approximate cost, $100,000. Engineer, Herbert Johnston.

LaSalle, Que.
Tenders on the construction of about five miles of macadam and concrete roadway for the Town Council will be received until 5 p.m., October 13th, by the Secretary, F. Lafleur, Town Hall. Engineers, Beique & Charton, 513 Transportation Building, Montreal.

Lindsay, Ont.
The Town Council propose to construct sewers and watermains at an approximate cost of $8,000. Engineers, Smith & Smith.

Maidstone Township, Ont.
The Township Clerk, W. R. Phillips, R. R. No. 2, Maidstone, will receive tenders until September 18th for the construction of a number of drains.

Nova Scotia Province
Tenders on the construction of three enclosed water tanks will be received until noon, September 27th, by J. W. Pugsley, Department of Railways & Canals, Ottawa. Plans and specifications at offices of the Chief Engineer, the Department, Ottawa, Chief Engineer, Canadian Government Railways, Moncton, N.B., and of the Engineer in charge, Dartmouth, N.S.

Ottawa, Ont.
The City Council propose to lay asphalt pavement and sidewalks on Somerset Street, at an estimated cost of $11,261. Commissioner of Works, A. F. Macallum.

Toronto, Ont.
The Board of Control will receive tenders until September 19th for the construction of asphalt, bitulithic and concrete paving and curbs on various streets. Specifications at office of the Works Department.

Walkerville, Ont.
The Town Council propose to lay about 6,000 square yards of concrete pavement, and will shortly call for tenders. Clerk, A. Miers.

Windsor, Ont.
The City Engineer, M. E. Brian, will receive tenders until September 15th for the construction of sewers, estimated to cost $5,000.

CONTRACTS AWARDED

Lindsay, Ont.
The Town Council have awarded the contract for the construction of asphaltic concrete paving to the Standard Paving Company, Limited, Central Chambers, Ottawa.

London, Ont.
The City Council have awarded the following contracts for sewer construction:—McLaughlin Brothers, Ottawa, $24,121; Webster Construction Company, Ltd., Bank of Toronto Building, $15,558; T. W. Nicholson & Son, London, $3,063; Mitchell & Nolan, London, $5,634.

Montreal, Que.
The City Council have awarded a contract for the supply of cast iron pipe to the Canada Iron Foundries, Ltd., 28 Victoria Square.

Contracts have been awarded to Kennedy Brothers, 364 University Street, for the construction of about half a mile of sewers at St. Lambert, Que., and for the demolition of the coaling plant and sand house at Sortin Yard, Montreal Junction, and re-erecting same on concrete foundations at McAdam Junction, N.B.,

Ottawa, Ont.
The City Council have awarded the contract for supply of pipe required in the construction of a watermain on Gloucester Street to the National Iron Works, Ltd., Cherry Street, Toronto. Approximate cost of work, $140,000.

Windsor, Ont.
The contract for laying concrete pavement on Moy and Erie Streets has been let by the City Council to the Chick Contracting Company, McDougall Street. Estimated cost, $6,424.

Railroads, Bridges and Wharves

Dundas, Ont.
Tenders on the construction of a reinforced concrete bridge are being received by John Douglas, Chairman of the Board of Works. Approximate cost, $3,000. Engineer, E. H. Darling, Hamilton.

Edmonton, Alta.
The Canadian Northern Railway contemplate the construction of about 35 miles of track from Edson westerly, and grading about 35 miles to the south of Dunblane. Engineer, F. Fraser, C. N. R. Station, Edmonton.

Red Deer, Alta.
The Canadian Northern Railway are building a temporary bridge over the Red Deer River, and will later erect a steel bridge. Divisional Engineer, A. T. Fraser, C. N. R. Station, Edmonton.

Toronto, Ont.
The Toronto Harbor Commissioners will receive tenders until October 2 for the construction of a steel bascule bridge over Cherry Street. Engineer, E. L. Cousins, 50 Bay Street.

Wainfleet Township, Ont.
The tenders received for the construction of seven concrete bridges were too high, and the work will be done by day labor. Clerk, Joseph Henderson, Marshville.

CONTRACTS AWARDED

New Glasgow, N.S.
The Town Council have let the contract for raising the dam at Forbes Lake to Peter Graham. Approximate cost, $5,500.

Vancouver, B.C.
The general contract for construction of the Coal Harbour causeway and sea wall has been awarded to the Cotton Company, Ltd., Vancouver, at $40,983. This contract does not include dredging and back-filling.

Public Buildings, Churches and Schools

Antigonish, N.S.
Plans have been prepared for a gymnasium to be built for St. Francois Xavier University. Brick and iron construction.

Lundar, Man.
The Nordurstjarna School District are considering the erection of a school at an approximate cost of $5,000. Secretary, A. Magnusson, Lundar.

Quebec, Que.
Tanguay & Lebon, 20 d'Aguillon St., have prepared plans for a school to be built on St. Luc Street for the Roman Catholic School Board. Tenders will be called privately by the architects. Approximate cost, $15,000.

Sault Ste. Marie, Ont.
George Drew, architect, 6 Queen Street East, desires to receive estimates on the installation of a cold storage and ice-making plant at the General Hospital. Plans at office of MacLean Daily Reports, Ltd., 25 Charlotte Street, Toronto.

Toronto, Ont.
It is proposed to build an art museum on the grounds of The Grange, and work may start on the first wing within six months. Architects, Darling & Pearson, Leader Lane.

Winnipeg, Man.
Tenders on tunnel work required in connection with alterations and additions to the Pathological Building for the General Hospital Board are being received by the architect, J. H. G. Russell, 1110 McArthur Building.

CONTRACTS AWARDED

Beeton, Ont.
The general contract for the erection of a school has been awarded to A. B. McKenzie, Georgetown, at $14,400. Architect, John Wilson, Collingwood.

Bruce Mines, Ont.
The general contract for the erection

ESTABLISHED 1886

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Preparing for the Bloodless War

THAT our neighbors to the south are carefully and systematically planning to profit financially and commercially by the exhaustion of the belligerents after the war, even as they are now profiting by a policy of "strict neutrality" during the war, is evidenced in many ways. For example, a few weeks ago an industrial commission was organized by the American Manufacturers' Export Association. Another indication is the recent decision of the American International Corporation to send investigators on a tour to Russia and to establish a permanent office in Russia.

In this same connection the Engineering Record publishes this week a lengthy interview with Mr. W. S. Kies, vice-president of the National City Bank of New York and the American International Corporation, who sees in the rebuilding of Europe an opportunity for United States contractors, engineers, and manufacturers, if they show ability to develop a close-knit organization for the solution of this great economic problem. Among other things, Mr. Kies believes that ready cash will not be available in Europe for this work, and that reconstruction work carried through by United States interests must be paid for largely by foreign bonds or other securities. The belief is also expressed that United States labor will not be required, since this will be available locally, but that United States capital, machinery, and engineers will be chiefly in demand, and it is suggested that "firsthand knowledge of local requirements, in France or Belgium for example, would be necessary before plans for any comprehensive construction programme could be financed. I think it is time now for American firms interested in this work to get together and establish in Europe an engineering bureau. Its personnel should be recruited from only the highest grade of men, representing the best brains in the engineering, construction, and manufacturing fields. Such a bureau could at once begin a study of the problem of reconstruction on a big scale and formulate working plans for the restoration of entire cities, or even groups of cities."

* * *

Mr. Kies, however, does not underestimate the value of the entente organization, which has been perfected during the war, and will doubtless evidence itself in reconstruction work as soon as the war is over, but he is "sure of the fact that Europe has obtained too clear a view of the fundamentals of industry to stop anywhere short of the quickest and most effective restoration, even at a measure of national expense. If as a result of the work of the American engineering bureau abroad we can show Europe that we have an absolutely certain supply of materials and machinery, an absolutely certain supply of capital, and an organization that can be depended upon for first-class, speedy construction on an enormous scale, the prospects of America's participation in the restoration work in Europe will be particularly bright."

* * *

This is an entirely laudable ambition, looked at from the angle of United States neutrality ideals. But we have every confidence that the allies, having satisfactorily completed the much larger task in which they are now engaged, will still possess in reserve a sufficient fund of wealth and vitality to carry on with all sufficient vigor the work of rebuilding France and Belgium. Surely the governments of France and England will see to it, too, that those whose moral sense of obligation to defend a "principle" has led them to give up everything that life holds dear shall not be robbed, by another, of any little commercial advantage that may follow the war, simply because the ideal of that other happens to be a commercial one. Quite aside from this, however, we do not see how there can be any set of men better fitted to carry on the work of reconstruction than those same engineers who have been in the thick of the destruction.

* * *

We trust our Canadian manufacturers will lose no opportunity of studying this matter carefully, so as to be in a position to act independently or to bring pressure on a somewhat somnambulant government to act for them. No doubt the entente governments and the commercial interests of the entente countries are well along with their plans. Let us keep in mind that it is to the victors the spoils belong. Next, in all conscience, the vanquished ought to rank. Only in third place if there is anything left, should the mere onlooker be admitted.

The Recognition of Canadian Engineers

THE Canadian Society of Civil Engineers are at last aroused to an active campaign against the increasing encroachment of alien engineers on the local field. The Contract Record has frequently pointed to this condition as entirely unnecessary, unpatriotic, eminently unfair to the Canadian engineering profession and a direct reflection on our own institutions of learning. That the foreign engineer is not infallible could scarcely be driven home to us more forcefully than in the second catastrophe which has just overtaken the Quebec bridge work. It will be remembered that the first Quebec Bridge had as a consulting engineer a man who was not a Canadian and practically admitted his neglect of proper supervision on the score that he was not being paid sufficiently well for his services. It will also be recalled that the consulting board of three which had the plans of the present bridge in charge included only one Canadian until quite recently. We do not know whether they considered they were not being sufficiently paid to give this work careful supervision, but we must conclude from the results that they did not do so.

This is only one of a number of cases, however, where Canadian construction work under the consulting guidance of alien engineers has turned out disastrously, though it is the one which stands out most prominently in the public eye to-day. The action of the Canadian Society, explained in the letter reproduced below, will meet the hearty approval of every citizen in the Dominion for, in making this decision, sentiment evidently played an insignificant part. There is no thought in this letter of deprecating the ability of the foreign engineer. It is only urged that the Canadian should have a fair chance to demonstrate his equal ability. It is the duty of every member of this society, and of every Canadian interested in the development of our country by those men who are interested in its development, to take an active interest in this question and make every effort to educate our governmental authorities, from Ottawa down, that our resources in brain power are just as outstanding as our resources in material. Failure of any considerable piece of engineering work in charge of a Canadian engineer, due to any lack of skill, is yet to be recorded. Why then this appearance of lack of confidence?

Below we print the letter which has been distributed within the last few days to the members of the Canadian Society by its secretary, Professor McLeod, of McGill University.

Canadian Society of Civil Engineers

176 Mansfield Street

Montreal, September 7th, 1916

Dear Sir,

The Council of the Canadian Society of Civil Engineers desires to call your attention to a matter of vital interest to the Society, and requests your personal action in connection therewith for the benefit of the civil engineers of Canada.

The Canadian Government, as you are aware, recently appointed a Commission to advise upon certain phases of the railway situation of the country. It is understood that the Government wishes to determine whether it should continue to assist private ownership as in the past by additional loans, or take over for itself the ownership and operation of certain railways, or allow them to go into receivership. The Commission consists of Mr. A. H. Smith, general manager of the New York Central Railway; Sir Henry Drayton, chairman of the Railway Commission of Canada: and Sir George Paish, financier, London, England.

The above Commission immediately appointed an American engineer as its advisor, and instructed him to organize a corps of engineers for valuation and advisory work. We wish to record our strong condemnation of the policy of placing in the hands of aliens the engineering work of a commission appointed by the Canadian Government to investigate Canadian railways for which the Canadian community has paid.

The inferences to be drawn from the employment of aliens in the above connection are that the Federal Government considers:

1st. That the Canadian engineers who built the railways are not competent to report upon them.

2nd. That the Canadian universities, in many cases enjoying Government subsidies, are not producing competent engineers; and

3rd. That the Canadian Society of Civil Engineers, although embracing a membership of about three thousand, is not considered worthy of consultation on an important engineering question.

The above mentioned appointment of alien engineers is not by any means the first of its kind, as many similar but possibly less flagrant cases have preceded it, and it is not improbable that the recurrence of such appointments may be due to the fact that Canadian engineers neither assert themselves nor demand recognition.

In order to impress upon the Federal Government the fact that one of its first duties is to encourage and develop the engineering profession in Canada in every possible way, the Council has selected this gross violation of a vital principle to initiate a campaign and impress the fact that Canadian engineers must receive due consideration. The Canadian railways, canals, public works and other engineering attainments are a proof that Canadian engineers stand in the front rank, and it should be quite unnecessary for them to have to appeal to their own Government for recognition.

It may be argued in support of the present alien appointment that Canadian engineers are not acceptable because many have been in the employ of the railway companies. To this we would reply that, as the Commission itself is to advise the Government, basing itself upon the engineering data given to it, any experienced engineers are competent to collect and submit the necessary information to the Commission.

It may also be argued that the Government gave the Commission a free hand in the appointment of an engineering staff, and, since this freedom of appointment is essential, our protest should be to the Commission itself. To this we reply:

1st. That when a particularly flagrant case arises such as this where competent constructing and operating engineers are passed over in favor of alien engineers, the question of the suitability of the Commission appointed by the Government for the work in hand comes into question.

2nd. A protest to the Commission itself would probably prove futile, and, even if successful, would

not in any way impress the Government, the creator of Commissions, in regard to future procedure in matters of this kind.

The Council of the Canadian Society of Civil Engineers, therefore, asks you to use your influence in every way to diffuse a knowledge of this matter throughout your community, and to place before those with whom you may come in contact the fact of the case and the position of engineers in relation thereto. Specifically, the following is recommended:

1st. That you write to your representative in the Dominion Parliament, whether Government or Opposition, setting forth the facts of the case in a strong way, and pointing out that this is merely an incident in a long course of similar procedures.

2nd. That you write in a similar vein to those having influence with the Government in your own community or elsewhere.

3rd. That wherever similar incidents are brought to your attention you voice a protest, giving the facts to your local branch of the Canadian Society of Civil Engineers or to the Secretary at Montreal in such a manner that the Council may deal therewith.

4th. That you do not delay acting in this matter as above outlined, but proceed to-day to do what you can to bring every pressure to bear in every direction for the good of the engineering community in Canada.

The Council requests that you will be good enough to fill out and return the accompanying blank to your Branch or to Headquarters if you are not a Branch member, in order that they may be fully aware of what has been done by the membership at large towards strengthening such representation as it may seem desirable to make to the Dominion Government.

On behalf of the Council,

C. H. McLEOD, Secretary.

The blank referred to is a letter reply form signed by the member to the effect that:

(1) He has written to certain (named) Federal representatives regarding the matter.

(2) That he has taken it up with other (named) influential persons, and,

(3) Advising of instances of engagement of outside engineers not considered justified.

Build Better Foundations

A road is no stronger than its foundation any more than is a house, a public library or a post-office. No matter how good the material placed on the surface, if the foundation be not sufficient to support the weight of traffic it will quickly develop holes and ruts. Is it not possible that Canadian engineers do not give sufficient thought to the possibilities of solidity in foundation, but devote more of their energy to trying to secure a passable surface? This sort of procedure is on a parallel with putting paint on rotten wood. The practice followed in so many counties of spreading stone on worn-out roads and simply rolling it flat, or allowing traffic to wear it down, could surely be improved on. It is at best only a temporary relief. In the State of New York the method usually adopted on old stone roads is to completely scarify the surface to a depth of six or eight inches and remove worn-out material. Crushed stone of one to two inch size is then spread and thoroughly consolidated. This affords a solid foundation for the surface coat which is usually of fine stone with Tarvia binder.

With the drying of the oil, of course, this fine stone is washed, or finds its way by gravity, to the shoulders, but this is provided for by having men continually shovelling this loose material back to the middle of the road, thus reducing to a minimum the tendency for traffic to follow a rut.

It would seem that putting a little extra money into the foundation of our roads and providing a little more for maintenance would, in the long run, save money for our taxpayers.

Royal Architectural Institute

The Royal Architectural Institute of Canada this year resumed its annual meeting which was held at Quebec on September 8 and 9, the first since 1913. Mr. J. H. G. Russell, of Winnipeg, the president, was in the chair. The meetings were held in the offices of the city council, where the Institute was received by the Mayor, Mr. Lavigueur, and welcomed by Mr. Marier, president of the Builders' Exchange. Mr. Russell replied in a brief speech.

The first day was devoted to meetings of the council. On the second day, it was decided to institute a competition for a design for a medal to be awarded to prominent architects. Applications for federation to the Institute (which now consists of the provincial architectural societies of Alberta, Manitoba, Quebec, Ontario and Saskatchewan) were received from the British Columbia Society of Architects and the Architectural Institute of British Columbia. As only one society in each province can be admitted, it was recommended that both B. C. societies join hands, and that representatives of this united society be admitted.

The Institute took up the question of the competition for the departmental offices and Supreme Court, Ottawa. The Government have retained six of the designs, but have taken no further action in the matter of coming to a decision as to which shall be selected. The Council, it was decided, should communicate with the Government on the subject.

A roll of honor of architects who have joined the forces is to be prepared. Out of the membership of 800, 100 have enlisted. Architects who have volunteered will be kept on the list of members without fee during their period of service. The financial report showed a balance of between $600 and $700. It was left to the Council to select the date and place of the next meeting, Hamilton being suggested.

The following officers were elected: Mr. J. P. Ouellet, Quebec, president; Messrs. A. Frank Wickson, Toronto, and W. G. Van Egmond, Regina, vice-presidents; Alcide Chausse, Montreal, hon. secretary (10th time); J. W. H. Watts, Ottawa, hon. treasurer (10th time); council, Messrs. D. R. Brown, A. Beaugrand-Champagne and Joseph Perrault, of Montreal; C. H. Acton Bond and J. P. Hynes, of Toronto; C. P. Meredith, of Ottawa; J. H. G. Russell, E. E. Matthews and Col. J. B. Mitchell, of Winnipeg; James Henderson and W. D. Cromarty, of Edmonton; R. P. Blackey, of Calgary; R. G. Bunyard, of Moose Jaw; A. G. Creighton, of Prince Albert, and H. Cooper, of Regina.

"Applied Science," in its June issue, just to hand, publishes the names of 619 graduates of the Faculty of Applied Science and Engineering of the University of Toronto who have enlisted, in one capacity or another in the war. Up to that date 16 of this number had been killed and 26 others wounded, 5 are prisoners of war, and military honors, so far, have been awarded to 8 of the school men. This will be the last issue of "Applied Science" until the war ends.

Sewage Disposal Works in City of Regina

By Mr. D. A. R. McCannel*

THE city of Regina has a separate sewer system, but owing to the storm water system being not fully completed as proposed, much storm water is taken care of by the domestic sewers. The average dry weather flow of the domestic sewer is about 2,000,000 gallons per day, which enters the pump house through a 48-inch reinforced concrete pipe. The sewage disposal plant is situated on the banks of the Wascana Creek, just outside the city limits, where the city has acquired about fifty acres of land.

The method of sedimentation, filtration and final sedimentation is used. The plant consists of a pump well into which the main sewer empties, a stand-by tank, four sedimentation tanks, eight filters and two final settling tanks, all of which were constructed at a cost of a quarter of a million dollars. Owing to the topography of the city and surroundings being very level, it was impossible to provide sufficient fall to allow for treatment by gravitation, so pumping has to be done.

The cost of operation and maintenance is about $11,000 a year, and a staff of four men are regularly employed, though additional help is required during the summer to clean the sedimentation tanks. The superintendent devotes half of his time to the plant, while the other half is required for other work. Chemical and physical tests of the sewage as it passes through the different units are made from time to time, these tests being required by the Saskatchewan Bureau of Public Health.

During the past year experiments have been carried out on a small scale with two activated sludge tanks, but at present sufficient results have not been obtained to warrant a report, although the results have proved satisfactory to date.

A brief description of the various units is given below, both as to construction and working.

Pump Well

The pump well consists of a reinforced concrete basin 25 ft. by 75 ft., with a longitudinal slope in the floor to a sump 15 ft. from the inlet end. The depth at the sump is 19 ft., and a retention period of 1.2 hours for average flow is provided. The four-foot outfall sewer enters the end of the pump well into a stationary box screen 8 ft. by 4 ft. by 11 ft. The screening is done by hand, being removed each morning, as well as the elevating of any solids that deposit, such as grit which is not lifted by the pumps. The pumping units consist of three electrically driven 1,000,000 gallon centrifugal pumps which lift the sewage 25 feet to the sedimentation tanks. The cost of operating the pump house is about 70 per cent. of the total cost of operation and maintenance. A brick structure 30 ft. by 25 ft., encloses the machinery and screens, while the balance of the pump well is covered by a corrugated iron roof.

Stand-by Tank

This tank, the dimensions of which are 200 ft. by 200 ft. by 10 ft., is constructed of reinforced concrete and is provided to take the surplus storm water. It is connected by a 48-inch overflow pipe and a 10-inch return pipe to the pump well. There is also a 48-inch overflow pipe from the stand-by pipe direct to the creek, but it is only during periods of excessive rainfall of long duration that the sewage enters the creek without treatment, and such sewage is very weak, being practically storm water.

Sedimentation Tanks

These are rectangular long flow tanks of reinforced concrete, four in number, each tank being 100 ft. by 50 ft., and having a capacity of 190,000 gallons. The floors of the tanks have a slope of 1:15 to the inlet end, where they are 9 feet deep. The tanks are all inclosed by a corrugated iron building constructed on a steel frame. These tanks were originally designed for sedimentation tanks only, and the settling solids were to be drawn off at frequent intervals, but it was found difficult to prevent the septic action from taking place in the deposited solids, owing to the difficulty of cleaning the tanks during the winter season. As later experience has proven that the filters will give better results when treating fresh sewage, "V"-shaped troughs have been proposed, and are at present introduced in two of the tanks, forming a two-storey tank. By the addition of these troughs the sewage passes through the tanks from one end to the other without coming in contact with the septicized sludge, at a sufficiently slow velocity to allow the suspended solids to settle into the lower chamber of the tank through a slot in the bottom of the troughs. A storage capacity of five hundred cubic yards is provided in the lower chamber of each tank. Each trough is four feet wide at the top, four feet at the inlet end and two feet deep at the outlet end, having a cross section of six square feet, which provides a retention period of 1.8 hours. A twelve-inch space is provided between troughs for the gas to escape and for scum to accumulate. The remaining two tanks have not as yet had the troughs constructed and they have scum boards suspended from the roof to prevent the scum from passing on to the filters.

Sludge Bed

The sludge drawn off from the sedimentation tanks discharges on the sludge drying bed, which is 200 ft. by 25 ft., and consists of a concrete floor with a layer of hollow drain blocks on which is placed a thin layer of crushed stone, through which the liquid drains to a drain pipe back to the pump well. When the sludge is sufficiently dry it is removed by teams and wagons, and this drying takes three weeks of favorable weather.

The sprinkling type of filter is used, there being eight; four circular and four rectangular. The circular form of filter was first constructed, and the rectangulars have been in operation only during the past year. The filtering media consists of one inch to three inches of broken field stone, and in the circular filters this is laid on hollow drain blocks, which rest on a concrete floor that slopes to the collecting channel at the perimeter. These filter beds are 130 feet in diameter, 7 feet in depth, which gives the four an area of .95 acres of 6 feet in depth. The sewage is applied by means of Adams revolving sprinklers, which operate under a 2.5-foot head, and require very little attention, mainly the cleaning of the arms about every

*Assistant Engineer on Sewage.

second day, due to the solids clogging some of the holes in the end of the arm. Each filter is housed in a corrugated iron building, and although the past winter's temperature lowered to 50 degs. below zero, the temperature of the filter effluent only lowered to 45 degs. F., and no trouble from frost occurred.

The rectangular filters are 168 ft. by 28 ft., with a 7-ft. depth, and the crushed stone rests on a layer of field boulders that are laid on the concrete floor, which slopes to the outlet end. These four filters provide an area of .5 acres, 6 feet in depth, which gives a total filtering area of 1.45 acres. The sewage is applied by means of Ham-Baker distributors, which operate by syphoning the sewage from a concrete trough placed between two beds and extending the length of the bed, into a supply pipe that feeds the revolving buckets. These buckets form a waterwheel which forces the distributor over the bed, it running on a track a foot above the bed. The reason for the change in the form of the filter was due to the decreased cost per unit area, there being twice the area of one circular filter in the four rectangular filters, and the cost was approximately the same.

Humus Tanks or Final Settling Tanks

The effluent from the filters is led to the humus tanks, which are two in number, each 80 ft. by 14.5 ft. by 4 ft., with a .75 per cent. fall to the outlet end. As the sewage enters these tanks it passes through a channel provided with baffles, where provision is made for the addition of a disinfectant. Each tank has a capacity of 65 cubic yards of humus, and considering 1 cubic yard per 1,000,000 gallons of sewerage, the tanks have to be cleaned every two months, which is done by elevating by hand into carts and then hauling away with teams.

The sewage passes over an outlet weir in each tank and then by a short length of 30-in. pipe is led directly into the creek.

Water Purification Plant at Medicine Hat

By Mr. R. B. Pyper*

OWING to the rapid growth of the city of Medicine Hat it was found in 1912 that the existing water plant was inadequate to supply the demands and it was decided to construct a plant of larger capacity with provision for extension at a future date, if necessary. The existing plant was situated near the centre of the city, and it was decided to build the new plant a distance of two miles further up the South Saskatchewan River, which is the source of supply, on a piece of property along the banks of the river, and owned by the city, and which is large enough to permit of considerable extension. A small power plant was situated on this new site, but as it also was too small for immediate needs, it was decided to increase the power capacity as well, and accordingly a combined power and water plant was built alongside it.

Water is taken from the middle of the river through a 30-inch cast iron pipe which delivers by gravity into an intake well on the bank. This well is built of reinforced concrete and is 18 feet in diameter and 45 feet deep. The end of the intake pipe is protected by a concrete abutment, the outer end of the pipe being coverd with a removable screen sliding in grooves in the end of the concrete abutment. On the top of the abutment is an emergency inlet which could be used in case the ordinary inlet clogged through some unforseen cause.

The water is pumped from the intake well through three 16-in. cast iron pipes, carried from the well in a tunnel which runs under the sedimentation basin and clear well to the low lift pump room, and thence delivered to the sedimentation basins. The low lift pumps, three in number, are motor driven and have a capacity of 3,000,000 Imperial gallons per day each.

The sedimentation basins are of reinforced concrete and have a total capacity of 750,000 gallons, which, with a minimum of three hours' sedimentation, yield 6,000,000 gallons per day. There are six filter units of the mechanical gravity type, each with a capacity of 1,000,000 gallons per day, and an area of 420 square feet. Directly under the filters is the clear well, which has a capacity of 125,000 Imperial gallons, and from which the water is pumped through a 20-inch steel main to a reinforced concrete reservoir of 3,200,000 gallons capacity, situated on ground 300 feet higher than the plant.

Aluminum sulphate is used as a coagulant, and generally speaking there are about four and a half months during the winter when it is unnecessary to use this material, or only sufficient to form a flock which will cover the filters, as the water in the river is clear and colorless during that period.

The average daily pumpage for the year 1915 was 2,100,000 Imperial gallons and the average quantity of aluminum sulphate used was 0.645 grains per gallon. The coagulant is applied to the raw water at the point where it enters the sedimentation basins.

During certain periods of the year the water is treated with calcium hypochlorite, which is added to the filtered water close to the suctions of the high lift pumps. The amount of this chemical used averages about 0.2 parts per million of available chlorine during the period when it is required.

No trouble has been experienced with coloring matter in the water excepting during a few days in February of this year, when exceptional conditions existed. Owing to a spell of very warm weather the large amount of snow lying on the prairies melted and caused a rapid rise in the river, which resulted in the ice going out and the water in the river being exceedingly turbid with a low alkalinity. This surface water was also considerably colored, and this with a low temperature required careful manipulation for a few days, but good results were obtained.

Samples of the water are submitted for examination at frequent intervals and it has always been declared as excellent for drinking purposes. The city has been particularly free from typhoid during the last two years, no cases being attributable to the water supply.

*City Engineer, Medicine Hat.

Excessive crowning of street pavements causes traffic to congregate on the car tracks, resulting in undue crowding of the street and interference with the right of way of vehicular traffic.

Engineering and Scientific Research

Advocating Industrial Investigation and Experiment to Produce the Highest Commercial Efficiency

ONE thing that has contributed very materially to the rapidity of Germany's industrial progress before the war, and, indeed, is of primary assistance to the present carrying out of the struggle, has been the intimate co-relation of engineering with scientific and industrial research. Our present enemy has always made it a point to further and assist investigation along scientific lines, with the object of applying the knowledge so gained in maintaining the highest pitch of industrial efficiency. While all may not—in fact, cannot—agree with the bureaucratic methods by which Germany operates this system, yet even the most conservative cannot fail to recognize in the principle, features and advantages that commend themselves as possessing a vast deal of merit, and that are, indeed, even of essential importance. The paper reproduced below, which was submitted at the Conference on Engineering and Scientific Research, England, by Prof. J. A. Fleming, M.A., D.Sc., F.R.S., M. Inst. E.E., gives some interesting and timely remarks in this regard, covering as it does a viewpoint specially applicable to the British Empire. Timely notice has evidently been taken of the importance of this subject by the Ontario Government, which recently announced through one of its cabinet ministers the intention to establish a department of industrial research in the University of Toronto.

In the particular matter under discussion we have been compelled to recognize the manner in which important industries have died out or never thriven in this country in consequence of our neglect of scientific education and research. It is equally important to realize that we cannot undo the effect of this neglect by a wave of the wand, but that reforms, to be useful, must be very deep and very thorough and begin at the top and at the bottom in our systems of national education. Whilst we cannot hope to reach anything like unanimity on a subject so complex as the means of imparting or creating knowledge, it is of the utmost moment that engineers should carefully consider the various proposals made for reforms, so as to bring to bear their practical experience on it and not permit schemes to advance too far which are the product merely of academic or political thought.

We have to consider, then:

1. The improvements in the training of men who will become engineers.

2. The best means by which scientific knowledge can be brought to bear on the problems of engineering.

3. The scientific method in relation to the business side of engineering.

The enormous destruction during the war of the products of the engineer's shop and office will call for reconstruction, and offer a vast field for engineering work on its conclusion. We have to see to it that as much as possible of this work falls into the hands of the united nations which form the British Empire.

This work will make a call for men trained both in the scientific and practical side of engineering, and also for others proficient in the business aspects of it.

It is unquestionable that the success of the Germans in the commercial field is, in part, due to their system of national education, which prepares every man for some vocation and does it thoroughly. We are by no means desirous of copying it in its entirety, as it possesses grave defects on its ethical side and in its extreme cultivation of materialism in its worst aspects. Nevertheless, we can usefully draw some lessons from it. Our own educational systems from bottom to top are too bookish, too much devoted to the cultivation of memory and words, and not sufficiently leavened by a real knowledge of the facts of nature and power to draw true inferences from observations.

One barrier in the way of our industrial progress has been the imperfect scientific training of foremen, managers, and young heads of departments in many engineering works. The young men who are brought in to fill directing positions have generally received the usual public or middle class school education, with its entirely insufficient attention to scientific subjects. Even when this has been supplemented by a course at a technical college, the time at the latter has been so much taken up with learning things which ought to have been learnt at school that the opportunity of acquiring advanced scientific knowledge or real power of independent investigation has been very much curtailed. Hence, when once immersed in business it has been impossible for them to keep up with scientific advances, and they can at most copy what they see others do. We have to produce more men who can do new things, and not merely know about old ones.

Thorough Scientific Education.

Until this state of affairs is remedied it is perfectly futile for Great Britain to hope to gain pre-eminence over Germany in scientific industries. The advantages which we have in greater originality of mind and better workmanship are neutralized to a large extent by the want of a sufficiently thorough and broad scientific education to enable us to see the practical value of, and work out exhaustively, and especially with reference to trade purposes, the openings given by scientific discoveries. It is the want of this sufficiently thorough scientific education which accounts for the limited faith of many employers and capitalists in scientific research, and also for the inability of the practical worker to take advantage of or see the meaning of facts which present themseves to him in his everyday work.

It is essential now for every engineer to have a good working acquaintance with certain branches of mathematics. If he has no knowledge whatever of the calculus or trigonometry he finds it impossible to read many original papers in the technical journals. In teaching electrotechnics to young engineers, I find I have to give much time to imparting elementary mathematical knowledge which ought to have been gained elsewhere. It should, however, be taught by engineers to engineers.

The great thing to guard against on the part of the student is premature specialization. He should broaden as much as possible his knowledge of the principles of chemistry, mechanics, physics, mathematics, and metallurgy, and he will then be able, later on, to build up on this foundation. Unless he does lay this

foundation he will not be able to follow or assist in improvements.

Relation of Scientific Research to Engineering.

We turn, then, to the subject which it is our purpose more particularly to discuss—viz., the relation of scientific research to engineering practice. We may roughly divide this research work into three departments.

There are, first, the laboratory researches which aim at determining various physical constants of the materials used in engineering which are requisite to give data for design. This knowledge can never be made too accurate or too complete; but the moment one goes to any of the well-known pocket books or tables of engineering data it is astonishing to find the wide gaps in our knowledge. Hence we require abundant provision for re-determining these values for particular samples of new materials to be used in bulk for various purposes.

Then, in the second place, there are those researches which aid engineering by providing new methods of examination and test of materials or structures. As an instance of this, consider the invaluable aid rendered by what is now called metallography, or the study of the internal structure of metals and alloys by the aid of the microscope.

Then, in the third place, we have a type of research which calls for special aptitude and insight—viz., those which lead to the discovery of some new process, material, or machine.

The really important question is, What are the conditions under which we can stimulate this originative power? It is partly due to natural gifts, partly to effective training, and partly to the possession of sufficient appliances and means.

Laboratories may, however, be built without number, and chairs and scholarships endowed, but unless the right men occupy them very little results.

The true answer to the above question is, I believe, that originality stimulates originality. A really great investigator not only discovers himself, but imparts something of his powers to his associates. No one can have worked under Lord Kelvin or studied under Clerk Maxwell without having caught from them some inspiration and some small fragment of their passion for the discovery of new truths and methods of doing it. Hence we require to establish and strengthen those research institutions such as the Cavendish Laboratory, Cambridge, or the Royal Institution, London, where notable scientific investigators have established schools of research and imparted some of their great powers to students and colleagues.

In Germany much of the technical research work is carried out privately by private associations of the trades concerned.

It is certain that, as a rule, British technical firms do not expend anything like the same labor or money over their intelligence departments as German firms. The latter gather in from all countries every scrap of information which can assist them, both from scientific and technical papers and patent specifications. This is carefully digested and classified, so that they are able to keep careful watch on progress in their own subject. The smallest valuable novelty is then carefully tested in practice. We need to improve in every way our means of classifying and notifying technical and scientific novelties and patent applications, so that it may become more easy to keep abreast of progress.

It is essential to guard against the bureaucratization of science, and the safest and most simple method of avoiding this would be to make the great technical and professional institutions the means of advising upon the most important steps to be taken in aiding technology. Suggestions have been put forward for the creation of a ministry of science. It is difficult to see how any such step will assist matters at present, while, on the other hand, it might be the beginning of a system of bureaucratic control which would involve a cumbersome and expensive machinery with much inertia and delay in giving assistance to genuine research. We have first to create a great change in the attitude of the public mind towards scientific knowledge and research, and develop the conviction that until it is regarded as a most serious pursuit we shall fail to make any firm advances toward victory in industrial war.

The importance of a true education in science is that it leads to love of accuracy as to facts, loyalty to scientific truth, unwearying labor in obtaining it, and care in the inferences derived from it. We have to cut ourselves adrift from all the past—its easy, self-satisfied mediocrity, dislike of trouble, and contempt for knowledge.

The first steps in this seem to be large reforms in education, and the second reforms in our system of party government, in which the true requirements of our national life are subordinated to the efforts to retain political power in the hands of individuals, clans, or parties. The only desirable form of government is an aristocratic government in the true and proper meaning of the term—viz., government by the most efficient and the best. The nation will have that government when it demands it in sufficient earnest.

Steel Houses for Soldiers

An interesting scheme is at present being discussed in connection with the building of large numbers of portable houses for the war zone. Certain of the Allied Governments are negotiating with manufacturers for the designing and building of these shelters, which, though intended to be temporary in character, must be durable and complete enough to accommodate family life for an indefinite period. Originally inquiries were put out for vast quantities of lumber from which to construct these houses, but it was found this material would make the cost excessive, and the plan was dropped. Now it is proposed to employ steel construction, which, if a uniform design is adopted, can be produced in great numbers at a minimum cost.

The proposed houses are to be 12 by 24 feet in ground dimensions and 9 feet high. They are to contain two rooms. A plan now designed calls for the use of a framework of light channels and a covering of 26 to 28 gauge galvanized sheets or some other un-inflammable material. Each of these structures will contain about a ton of steel. If this type is adopted the aggregate steel requirements will be enormous in view of the great numbers required. France alone has been considering the ordering of 100,000 houses, and the other entente powers are expected to order in equal proportion.

The houses are to be used both to shelter the soldiers at the front and to provide comfortable accommodations for the general inhabitants in devastated territory until the final reconstruction work in these districts can be safely inaugurated.

The Dominion Water Power Branch of the Department of the Interior, J. B. Challies, C.E., superintendent, has issued a progress report on the Manitoba hydrographic survey for the calendar years 1912-13-14. The report is by M. C. Hendry, B.A.Sc.

The Future Status of Sanitary Engineering

How the Period of Recuperation After the War will Affect Engineering and Particularly Sanitation

OF the many problems that will be an outcome of the war one of the most important and, withal, one open to a great deal of question, will be the matter of money expenditure to secure the maximum benefit in building up and retrenching after peace has settled upon us. There will presumably be a tendency on the part of many of those citizens who are unacquainted with the economic value of engineering works to object to the application of money to projects of this nature. They will feel that such sums could be more usefully expended for more productive objects, in this way better serving the nation's interests. The way in which this point of view will affect engineering matters and sanitation in particular is a matter of speculation. Mr. A. P. I. Cotterell, M. Inst. C.E., F.R. San.I., in his presidential address to the Institute of Sanitary Engineers, discusses this problem, especially in regard to sanitary development, and we reprint his paper, in part, below:

In the days to come what is likely to be the status of sanitary engineering? This is the question that I wish to consider, not to answer, for this would need the insight of a prophet, a title to which I do not aspire—but to indicate, if I may, some of the directions in which an answer may be found. We all say or acquiesce in the statement that things will never be the same when this war is over as they were before. Changes vast and far-reaching are taking place, and the world, we declare, will never return to its old ways any more than the grown-up boy who has once seen life can go back to the habits of childhood.

The question is vital, and demands consideration. It stretches much farther than the mere interests of our profession. It is woven into the life not only of our nation, but of all nations, and from the standpoint of regard for humanity is well worthy of our thought.

In an illuminating article published by the Contemporary Review in October last, a well-known social writer—Mr. B. Seebohm Rowntree—discusses some of the social and industrial problems that will confront us as soon as peace is signed. In his view industry will pass through three stages after the war—first, a period of very serious dislocation of trade, causing much unemployment, and probably lasting for several months; secondly, a period of feverish trade activity, lasting for a year or more; thirdly, a long period of severe trade depresssion.

I find that this forecast is also held in other quarters, and I think it may be taken to be a fairly accurate view of what is likely to happen industrially after the war, so far as any opinion can at present be expressed.

Judging from recommendations made from time to time by those qualified to consider the subject, it is possible that the first period of dislocation may be partly bridged by the resumption of public works that had to be set aside on the outbreak of the war. These will naturally include much that we as a profession are directly interested in, and, if such be the case, will involve considerable sanitary activity. But what we want to know is: How will sanitation stand when this period and that described by Mr. Rowntree as one of feverish trade activity have passed by and trade depression sets in?

At first sight it would appear that all sanitary work will have to be cut down to a minimum, only such things as are in the general view absolutely indispensable being proceeded with. Then comes the further question: "To what extent is sanitation absolutely indispensable?"

Now, it seems to me that the country generally will after the war aim intensely to invest both capital and labor in productive expenditure. If there has to be unproductive expenditure—and this is almost certain to be the case to some extent—it will be the national desire to reduce it to the lowest possible point. Productive expenditure will probably be differently regarded by the private individual from what it may be by the state. The individual will look out for what will bring in an immediate return without stretching his glance too much towards the future.

Is Sanitary Work Productive.

We can then ask the question: Is sanitary work productive? I expect I am not the only one who has heard before now that the outlay upon sewage disposal works might have been better spent, that the pollution of our streams is a matter largely of sentiment, and that the inhabitants of the country village are not likely to live any longer because they are to have a system of water supply instead of the dip wells used by their forefathers. We are said to be too squeamish; we do not like smells; no one has ever traced an epidemic to such causes, and it does not follow, so it is asserted, that they ever will.

It is admitted that a water supply is important in some respects. It may be essential for a large town, but for a country district is it not a luxury in which in a hardier age no one would have dreamed of indulging? After all, say such people, even if things are not quite perfect, and the village pump or the dip well does not always bring up pure water, yet there is plenty of fresh air in the country, and you must not expect town conveniences among the cabbages. The same arguments may not quite apply to our urban and semi-urban populations; but here, again, is it not possible to go too far and too fast?

We have made great improvements in our towns. Can we really afford the millions of pounds needful to carry out schemes of town planning and development? We have effected improvements by pulling down slums and creating open spaces in spots where formerly the people were crowded together like rabbits in a warren. It may be admitted that the conditions are not ideal, but if it becomes necessary to look at every sovereign, shall we not have to put up with a great many of these inconveniences, or even with unhealthy surroundings, at least for a while longer, until the country rehabilitates itself with commercial enterprises that bring in a more immediate return?

I venture to claim, in reply to these questions, that sanitation is in a very real sense productive work, and one of the most reproductive that a nation can devote itself to. There is urgent need to revive and enlarge all the vital forces of the nation. After all, no matter how far we advance in commerce or in capital wealth, it is nothing but ashes and destruction if we do not at the same time grow a healthy people to partake of it.

The war has taught us that we stand and fall together, and that the national well-being is a vital consideration, both for the "rich man in his castle" as well as "the poor man at his gate."

After the War.

Shortage of money is bound in the immediate future to be a pressing problem. Although the British nation, on account of its great wealth, will in this respect be better off than any other belligerent nation, yet it must also feel the pinch of circumstances. Will even it, then, be prepared to spend capital on sanitation?

We know the British nature, born of a laudable spirit of independence, and how it dislikes being told to use its wealth in any direction of which it does not clearly see the full benefit. It claims to do what it likes with its own, and, although generous and altruistic when its inner nature is touched, it hates to be regulated. Sanitation does regulate. It imposes restrictions and burdens on the individual for the benefit of the whole body. It makes part of the community who may be well off contribute to the well-being of those whose lot is not so favorably placed. It does so because it claims that epidemics, when they come, touch rich and poor alike, because the betterment of the lowest grade of the community benefits all the grades above it.

Yet, when the pressure of taxation makes itself felt, it seems to me that many will ask questions in regard to public sanitary measures such as these: Is it wise to carry out such works now? Can they not wait? Will they not hinder the application of money to other apparently more productive objects? Could not the interests of the nation be better served by keeping down rates and using the money saved in the development of trade? These are perfectly reasonable questions, and rightly demand an answer.

It might be claimed that the first object of the country is to stimulate its manufactures or to develop its mineral wealth, or even to set its agriculture on a more scientific and secure basis. Not one of us, I venture to think, will deny that all these are worthy objects, and in some form or other should be the concern of the community. Yet I suggest that it is just here where brains should come in to enable us to see the real way of attaining these ends.

What, after all, are they without a healthy people to work for them and to participate in their benefits? We want the nation to flourish. Then it will be true foresight to lay out capital, lavishly if you will, so long as it is not wasteful, in building up a strong and virile people, who shall be able to do these things. Brains will be needed in the future, perhaps more than money; organization more than immensity of material wealth.

But here we come up against a characteristic of the British nature, the determination to devote attention to practical things, and to leave theory and experiment to others. We sanitarians know it; we have encountered this ancient British prejudice again and again, until it has almost become an old friend. But we know it also to our cost. We know too well that often at the back of the commercial mind has been a tendency to deprecate our special knowledge, or to value it little more than that of a skilled mechanic.

Setting this aside, however, the characteristic of valuing the practical more highly than the scientific is a factor to be reckoned with in considering the future of sanitation. One of the changes many of us would like to see would be the welding together of the two, so that the practical man may be more scientific and the scientific man more practical. It seems to me that it is in this direction true progress will lie. But it means laying aside many a cast-iron tradition, and an appreciation of the value of things that do not always appear to bring in an immediate return. Sanitary engineering is one of these. It may for the moment appear a wasteful outlay; in the end it is one of the best investments that the nation could have made.

Now, what does all this amount to? We have, so far as we can see, a condition of affairs approaching when the funds formerly devoted to sanitation will be restricted, and there will certainly be a financial inducement to reduce the amount of money spent upon sanitary engineering. On the other hand, the need to rebuild the stamina of the peoples as rapidly and as soundly as possible will be urgent. Will the nation see that in the health, comfort, and upbuilding of its community lies the surest and most profitable return for any capital it may lay out?

The Construction of a Theatre Floor

BUILDING operations are progressing very favorably on the construction of the new Princess Theatre, Toronto, which is being erected to replace the old playhouse destroyed by fire some time ago. The body of the new theatre is being built with a steel frame and terra cotta facing, while the front portion, containing the entrance rotunda, and mezzanine floor, has solid brick masonry walls. At the time of writing, the floors in the entrance rotunda and mezzanine are being laid, and, although the system employed is not by any means new, its use in Canada has been limited to a certain extent, and, therefore, a description of the type of reinforced floor that is employed in this case will not be out of place, inasmuch as it possesses certain merits of value.

The illustration (Fig. 2) reproduced herewith shows a small portion of this floor, but with the tile and reinforcement in place, and before the concrete was poured.

Numerous types of floors have been designed for larger buildings employing concrete, tile, brick, steel, or some combination of these. For fireproof structures floor systems embodying hollow tile blocks in some manner or another are much in favor. These

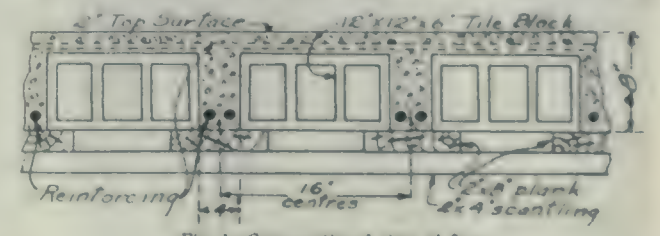


Fig. 1—Cross-sectional view of floor.

possess admirable fire-resisting features, and are, at the same time, very reliable, light in weight, and easy to instal. The most commonly used floors of this nature employ arch constructions of either the segmental or

flat type, with a reinforced concrete filling or covering. In such a floor the tile arch must be capable of taking the entire floor load. Floors designed on this system have certain disadvantages and objections. Solid reinforced concrete floors are eminently suitable for most purposes, but the large dead weight is often a serious drawback.

The floor described in this article was projected to overcome, in some measure at least, the disadvantages pertaining to both the types mentioned above. In this floor concrete is employed as the chief load-resisting material, with hollow tile acting as a filler to relieve or reduce the dead load of solid concrete construction and at the same time not decrease the capacity. There is no arch action, but the system simply resolves itself into a series of beams or joists at close centres (16 inches), which bear the load and convey it to the walls. The tiles employed in this case are three-celled square blocks, measuring 12 in. by 12 in. by 6 in. These are laid in rows on plank centering, with a 4-in. space between the rows. These spaces are filled with concrete, which is continued above the tiles to a depth of a 2-in. layer of concrete. The floor is thus practically a series of concrete joists, 4 in. by 8 in. in size, at 16-in. centres. These joists are carried on concrete beams 12 in. by 14 in., spaced 10 ft. apart. The beams, joists, and floors are all poured at the same time.

The reinforcing consists of two rods in each joist, one a straight bar, the other a trussed rod, with cross rods in the floor surface. The beams are also, of course, heavily reinforced. The tiles at the end of each row are plugged so that the voids cannot be filled with concrete. Grooves in the outer surface of the tiles act as a bond to prevent them falling out when the concrete shrinks on setting. A cross section of the floor is sketched in Fig. 1.

The concrete is designed to take care of nearly all of the load, the tile in this case serving to lighten the floor and to save the concrete. The tile can be removed without injuring the floor's stability, since there is no arch action, or if left in place (as it will be in this building) provides a flush surface for the plaster coat.

The saving in weight is about 60 pounds per equare foot of floor area for the size of tile here used, while the tile will carry, it is calculated, as much load as the concrete it replaces. There is no direct saving in cost, since the terra cotta blocks are practically the same price as the same volume of concrete, but an indirect saving is effected, however, in the decreased carrying capacity required in the main walls and foundations due to the lighter weight of the floor.

The centering used in this particular instance consists of 2 in. by 8 in. planks, spaced 8 in. apart, to carry the tile. With a solid concrete floor close centering would be required, but with 1-in. boards only, so that there is no saving in material. The cost per square foot of floor area, for centering, tiling, concrete, and steel, averages 34 cents to 38 cents.

Another advantage regarding this floor is that pipe-holes can be pierced through the tile without impairing the capacity of the floor, whereas in a tile arch construction holes materially weaken the structure.

The required depth of floor depends on the span. On the ground floor, where the beams are at 10 ft. centres, 6-in. tiles are used, with a total depth of 8 in., whereas on the upper floor, with the beams spaced 15 ft. apart, the tiles are 8 in. deep and the floor 10 in.

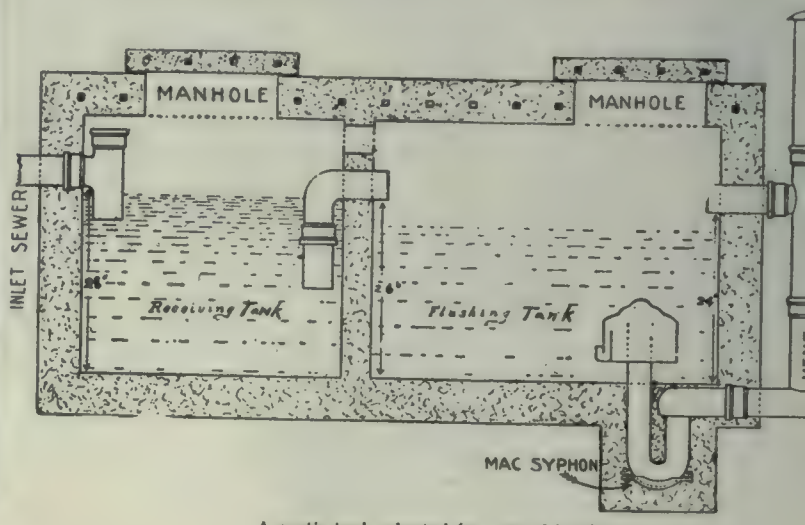
The illustration in Fig. 2 shows the general layout of this floor, and illustrates the arrangement of tile and steel. The arrangement is most clearly seen in the left-hand lower corner of the photograph.

Fig. 2—General view of floor showing tile and reinforcement in place.

A Septic Tank for the Country Home

Nowadays it is easily possible to carry most of the conveniences of the city homes into the country at a comparatively small expense. One of the greatest advantages in any home is a sewage disposal system, which is easily possible with a properly designed septic tank. However, careless or inaccurate designs have been responsible for much of the slow growth of popularity of this system of sewage disposal, and we reproduce herewith a drawing of the design of an approved tank, with a brief description.

Ordinarily there are two small tanks, the first known as the receiving tank, the second as the flushing tank. Preferably these are made of concrete, as in the drawing herewith. Of course, the size of the tank will vary with the amount of sewage to be disposed of, but for an ordinary household a receiving tank 3 ft. x 3



A septic tank adapted for a rural locality.

ft. x 3½ ft. deep, and a flushing tank the same size, wil be sufficient.

The side walls, the bottom and the top should be about 6 inches thick, the top being reinforced, as shown, with iron rods. The manhole covers should also be reinforced. A 1:2:4 mixture of concrete is best, and, after the concrete has set for a couple or three days, the tanks should be plastered inside with a mixture of one part of cement to two parts of fine sand. Care must be taken to install the syphon and the various pipes shown as the concrete walls are built up.

The diagram illustrates the general construction of the septic tank system. Four-inch pipes should be used throughout. The inlet should be so arranged that the sewage enters below the surface, but the upper end of the tee should open to the air. The overflow is adjusted that its opening is about midway between the surface of the water and the bottom of the tank. Two or three tiles should be placed in the separating walls between the two tanks, at the top, for ventilation.

An important feature of any such system is the syphon, and the one illustrated in the drawing herewith is known as the "Mac" syphon, one of the most satisfactory that has yet been placed on the market. It is manufactured by the West Toronto Foundry, corner Mulock Avenue and Junction Road, West Toronto.

After passing through the syphon from the flushing tank the fluid is distributed by means of ordinary drain tile over a considerable area, such as a lawn or garden. The tile is placed from 6 feet to a foot below the surface of the ground, and installed as level as possible. In general, the tile is laid in rows from 6 to 8 feet apart, and not longer than 30 or 40 feet. Either 3-inch or 4-inch tile may be used, and the amount will depend on the size of the tank. For the size in question it is advised that about 350 3-inch tile, or 225 4-inch tile, would be required.

Lasalle Bridge, Montreal

A marked difference between the highest and lowest tenders was shown in the bids received by the City of Montreal for the construction of the Lasalle bridge and head gates in connection with the enlargement of the aqueduct. With one exception, the firms bidding were local, and the variation in their bids may be seen from the following figures: Foundation Company, $315,527; John Quinlan, $270,845; Laurin & Leitch, $268,375; Bedford Construction Company, $239,792; L. A. Ott, $239,872; T. O. Sullivan, $226,221; Lessard & Son, $245,955. The time to be occupied in doing the work also varied, and ranged from 140 to 450 days.

The bridge, situated at the point where the aqueduct joins the River St. Lawrence, will replace a wooden structure on through plate girders resting on old masonry piers. The contractor will have to remove this structure and construct a temporary road over the top of a dam built for the purpose of enlarging the aqueduct. This temporary road will be for the purpose of facilitating the construction of the new bridge.

The work will consist of three head gates, a bridge, roadway, piers and abutments, operating platform, etc. The gates will be 58½ feet long, 18 feet high, with a normal lift of 17 feet, under a maximum head of 23 feet. At the top the leakage must not exceed the equivalent of a continuous opening ⅛ in. in width. Each gate is to be a structural steel frame, consisting of two vertical end girders, between which five horizontal girders will be rivetted. Between the latter vertical ribs will support a steel skin plate extending over the whole front of the gate. The hoisting mechanism is to be placed in towers, which are carried up from the piers and abutments. The hoisting mechanism for each gate, operated from a platform constructed above the roadway, will consist of two winches, to be hand-operated; provision, however, is made for the use of electricity. The gates will be raised by means of steel wire ropes, while four counterweights are to be provided for each gate. The total weight of the gates is 390,000 pounds.

The bridge will be 251 feet long, and is supported by two piers and two abutments, with reinforced concrete spans. The roadway is to be 36 ft., and two 5 ft. sidewalks are to be laid, double lines being put in for the street cars. The parapet, with an Indiana limestone coping, will be ornamented with 380 balusters. The piers and abutments will be carried to 33 feet below mean water level, and a cut-off wall between the piers and abutments to two feet lower than the piers.

The roofs of the towers will be of dark red Spanish tile on a covering of roofing felt. Steel ladders from the piers will give access to the operating floors in the towers. The head gate openings in the sides of the towers will have steel guards, and in the two end towers entrance platforms and staircases of structural steel will be provided.

The track pavement on the roadway is to be of granite sets on a one-inch bed of sand and a concrete base, while the roadway will have a bituminous pavement. The contract also includes the construction of two brick sewers to connect with existing sewers.

The entire structure, apart from the gates, will be of concrete, the reinforcement being of plain bars, structural steel grade.

The bridge was designed by L. G. Mouchel and partners, Toronto, and the head gates by the Dominion Bridge Company, Montreal. Mr. P. E. Mercier is the chief engineer of the city, Mr. T. W. Lesage engineer superintendent of the waterworks, and Mr. F. E. Field resident engineer of the filtration plant and aqueduct.

Toronto Branch C.S.C.E. Hold Smoker

The Toronto branch of the Canadian Society of Civil Engineers opened the winter season with a very successful smoker at the engineers' club rooms on Thursday evening, September 14. Mr. H. G. Acres co-operated with the chairman, Mr. G. A. McCarthy, and the secretary, Mr. L. M. Arkley, in supplying the members with a very entertaining and enjoyable programme. The date and programme of the October meeting will be announced at an early date. It is probable the discussion will centre around the recent Quebec bridge mishap.

Mr. George H. Power, of Chipman & Power, civil engineers, Toronto, in his evidence which he recently gave before the Haultain Commission, made statements to the effect that the waterworks and sewage system of the asylum at North Battleford, Sask., cost $83,000 more than it should have done.

The sixth annual report on wholesale prices in Canada for the year 1915 has been issued by the Department of Labor. The report is replete with numerous charts and tables showing the trend of wholesale prices in Canada from 1890 to 1915.

Proper Method of Laying Oak Flooring

Stock should be examined to ascertain if it contains moisture—Filler to be applied as soon as possible after laying completed

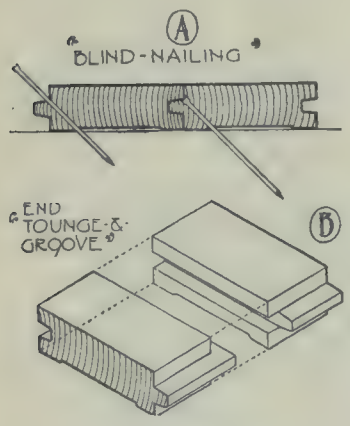
By W. L. Claffey

TO-DAY, by improved machinery, equipment, and quantity manufacture, the cost of making flooring has been so reduced that beautiful oak floors are now within reach of everyone.

Oak flooring is generally laid by a profession commonly known as floor-layers, who specialize in the laying of hardwood floors. These floor-layers may be divided into two classes — good workmen and a class that are careless. The expert floor-layer obtains his reputation by the high class and perfect work that he turns out. It is practically his only asset in the game. Many large and prosperous floor-laying concerns have reached their prosperous condition chiefly through conscientious workmanship in their earlier days. The floor-layer who is careless in his work will never succeed.

It is not necessary to be an expert to produce a good floor-laying job, but it is very essential that considerable care should be exercised, and all the details, from the very start to the finish, should be carefully studied before the floor-laying work is taken in hand.

Before starting to lay oak flooring the stock should be examined to ascertain if it has absorbed any moisture while at the lumber yard, on the wagon, or at the job, as usually during rainy weather oak flooring will absorb considerable moisture, mostly at the ends — thereby causing it to swell as much as one-sixteenth of an inch. If this condition is not discovered before the floor is laid, unsightly crevices will appear in the floor. The sub-floor, as well as the plaster work, should be thoroughly dry before starting to lay oak floors. If in winter, the rooms should have a temperature of about 70 degrees to insure the best results, and the oak flooring bundles should be in the rooms at least ten days to thoroughly dry out, in case the stock has been subjected to any moisture, before the main work is started.



OAK FLOORING

Oak flooring leaves the mill in perfect physical condition, but is very often abused by improper handling before it reaches the job. There are many lumber yards and contractors that almost treat oak flooring like rough lumber. This is a mistake.

The sub-floor should be thoroughly swept, and it is well to use a damp proof paper, and where soundproof results are desired a heavy, deadening felt is recommended.

The sub-floor should be of serviceable wood, but not less than 7/8 in. thick, dressed one side to an even thickness. Sub-floors should be nailed securely to the joists, but not driven too tight together so as to permit it to swell, then bulging; 4-inch to 6-inch strips are preferred widths for sub-floors.

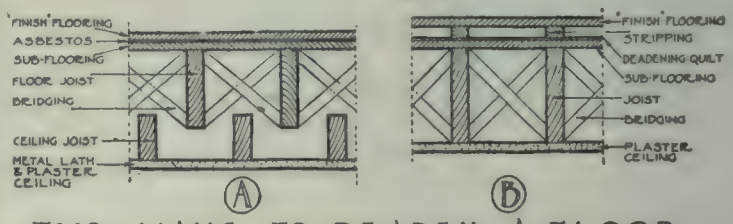
When starting with the first oak flooring strip it is well to leave at least 3/8 in. for expansion space between the first strip and the baseboard, and likewise at the other end of the room, as there is more or less expansion and contraction in all kiln-dried oak flooring.

Oak flooring should always be laid at an angle to the sub-floor, and, after laying and nailing three or four pieces, use a short piece of hardwood. 2 in. x 4 in., placed against the tongue and drive it up with a heavy hammer.

The nailing of oak flooring is very important. All tongued and grooved oak flooring should be blind nailed. The best flooring made can be spoiled by the use of improper nails. The steel cut variety is recommended for 13/16 in. stock—use 8-penny nails every 16 inches; for 3/8-inch flooring use 3-penny wire finishing nails every 10 inches. If even better results are desired the nails can be driven closer.

A floor-layer should use discretion in regard to certain strips that do not blend in color with the majority of strips. A few badly discolored pieces in a room will mar the appearance greatly. Bad discolored pieces should always be set aside and used in closets and other out-of-the-way places. Where there is a wide variation in color it is good policy to separate the pieces before they are nailed down. This insures a more regular run of color, and blends better together than if scattered throughout all the rooms. Every floor-layer should watch this feature of his work closely, as it is the appearance of the floor after laid that counts.

Oak floors, with some care, should last a lifetime,



TWO WAYS TO DEADEN A FLOOR

and it is for this very reason that all floor-layers should be very particular when they lay oak flooring. The wood itself is practically never permitted to wear —that is, in the better grades that are used in homes. It is the wax or varnish finish that wears, which is always replenished. Honest and careful workmanship on the part of the floor-layer spells success. A good job of floor-laying is the best advertising, while a poor job gets nothing but kicks and no reward.

Scraping oak floors is always done in the better grades, or in all homes where people dwell. In order to get the best results for a nicely finished surface it is best to scrape it. This scraping process can be done by the ordinary scrapers, such as used by cabinetmak-

ers, or by one of the many types of power or hand machines that are generally used by contractors and carpenters. Always scrape lengthwise of the wood, and not across the grain. A floor properly scraped looks very smooth, but it should be thoroughly gone over with No. 1½ sandpaper to obtain the best results in finishing. After this the floor should be swept clean and the dust removed with a soft cloth.

The floor is then ready for the filler, which should be put on as soon as possible after the laying work is finished, as the filler fills up the pores of the wood and keeps it from shrinking.

The Design of Monumental Bridges

By Gustav Lindenthal*

When speaking of monumental bridges, the usual understanding is of large bridges of great span, but such structures have been built only in the last ninety years, and that definition would not seem to be fair to the master bridge-builders of preceding centuries. Although with few exceptions their names have not been preserved, their work should receive fitting appreciation from the modern engineer.

We can properly regard all bridges as monumental which, in their construction, record a decided progress over preceding constructions—that is progress in design, in methods of erection, in workmanship and in architecture. Each bridge which from that point of view shows features of originality is a monument along the road of creative genius.

Before the development of the mathematical laws of statics, some ninety years ago, the longest spans attempted were in wood, about 140 ft. and about 100 ft. in stone arches. The ancient bridge-builders derived the dimensions from experience, attempting longer and longer spans, without accurate knowledge of the forces that a bridge has to sustain.

During the middle ages in Europe architects and builders learned, probably from Arabian and Moorish sources, to use the principles of the funicular polygon for determining the forces in arches.

German cathedral builders used models and the so-called "Bauwage" (the building balance) consisted of a suspension chord supporting the weights representing the loads upon the arches, and under which the suspension chord assumed the equilibrium form. In this manner the architects of the mediaeval ages were enabled to determine approximately the forces and dimensions of the bold and lofty vaults in cathedrals which we admire to this day.

Of many of the old bridges the designers and builders are unknown, yet their work shows a profound study of the principles of equilibrium and nice adjustment of form to load and strength of materials, and in many cases such superior taste and workmanship, particularly in masonry, that we have hardly any to-day to match it, notwithstanding our superior tools.

The historians of those times had a higher regard for the speculations of scholastic philosophy, the principles of which were considered and recorded as the highest exponents of science, than for the practical arts of building and architecture, the masters of which went unrecorded. Yet their work, exemplified in ecclesiastic buildings, in great castles and in bridges, was truly monumental considering the difficulties overcome and the limited resources of those times. It behooves us engineers, as their successors in the art of construction, to honor them, although largely unknown to us, and to cherish a just appreciation of their skill.

The early stone arch bridges were built in semi tropical and tropical climates, where the action of frosts is never felt as a disturbing cause in masonry. Therefore, stone arches, like other stone masonry, could be laid without mortar, with tight-fitting joints whose exquisite workmanship evidences the great skill of ancient mechanics.

Although bridge-builders could not indulge in long spans, they showed great enterprise and resourcefulness in building long bridges over wide rivers and of great boldness of design, as at Babylon, when a new river bed was first dug out, into which the Euphrates River was diverted, so that a great bridge could be built over the old river bed. That was about 3,000 years ago. The principle of cofferdam foundation was practised that long ago.

The Babylonian, Egyptian, and Greek civilizations became acquainted with the principle of the arch only after the Romans. There are records of arch bridges in China older than the Romans, and older than the arch is the principle of the cantilever found in the earliest structures, together with the principle of the beam.

Suspension bridges occurred only as unimportant structures with the roadway carried on flat ropes of some fibrous material. Metal was too expensive for the fabrication of suspension chains. The carrying of large stones and enormous slabs from granite quarries and their transportation over long distances was practised in China, Persia, and Egypt for temple as well as for bridge construction centuries before the Christian era.

During the dark centuries preceding the Crusades, the traditions and knowledge of arts and sciences were preserved by the priests and monks, living in their castle- like monasteries. Just as in ancient Rome the first bridge-builders formed a guild and order of which the head priest was called the Pontifex Maximus, so orders of monks became again the first bridge-builders in the Christian era after the Crusades, when order was gradually restored after centuries of anarchy. That title of Pontifex Maximus had become one of the greatest honor among the Romans, and when the Bishop of Rome became the recognized ruler of the Christian Church and of Rome he became heir to that title, which he carries to this day.

General poverty in resources and the entire absence of public spirit in the feudal ages had been a hindrance to the development of bridge construction as to everything else. Only as the wealth of Europe increased was the skill of architects and builders also availed of for bridge construction. From the building of castles for the feudal aristocracy the art of building was transferred to the towns and cities, and along with the construction of great cathedrals came also the construction of some noteworthy stone bridges. Progress was slow, however. Some of the bridges required for their construction from 50 to 150 years.

With the beginning of the fifteenth century we may observe the length of spans gradually increasing. In the beginning of the nineteenth century the general

* Consulting Engineer, New York, N. Y., before Cleveland Engineering Society.

improvement in road construction extended also to bridges. Later came the demands of the railroad age, beginning in the fourth decade of the last century, for larger and heavier bridge structures and longer spans. Iron came into use as the ideal material. Its production in great masses and with great economy made this new material the most decisive factor in modern bridge construction, and it has become a highly developed science on a mathematical foundation.

Our present age, the "age of iron and steel," will surely pass away with the exhaustion of the limited quantities of iron ore and coal in the earth's crust. Estimates run from 200 to 300 years for iron ore and somewhat longer for coal. This iron age should leave a number of great monumental bridges built of steel in massive and durable form to convey to posterity thousands of years away, the power and resources of our times, which will probably then be only legendary.

A number of works have been written in various languages on bridge architecture; on book of great merit is, for instance, that by H. G. Tyrrell, published in this country a few years ago. It is a gratifying fact that the purely utilitarian point of view so prevalent in bridge construction is now gradually changing. Where the location and surroundings of a bridge require architectural treatment it is always feasible to combine the useful with the beautiful, to give artistic expression to the purpose of the structure, which is the true essence of architecture.

All connoisseurs agree that the appearance of a bridge is the more pleasing the clearer and simpler its architecture conveys to the mind its function. Decorative features should be used only sparingly, and should be attempted only by artists of a high order. The Alexander bridge, in Paris, is in this respect a rare example of a truly beautiful and balanced decorative architecture. A little too much and its exquisite decoration would verge on the vulgar; a little less in one place would require simplification in other places, impairing the dignity of the whole.

The famous American sculptor, Horatio Greenough, the designer of the Bunker Hill monument and the modeller of the colossal statue of Washington in front of the national capitol, gave a definition of what an artistic structure should be in a letter to Ralph Waldo Emerson, about 1840.

He defines an artistic structure to be "a scientific arrangement of form to function and to site. An emphasis of features proportioned to their gradated importance in function, color, and ornament to be decided and arranged and varied by strictly organic laws, having a distinct reason for each decision. The entire and immediate abandonment of all makeshift and make-believe."

The appositeness of Greenough's definition can readily be verified in ancient and modern bridge structures alike, either by the presence or absence of the features on which he lays so much stress.

One of the first aesthetic conditions should be symmetry of design, which will always give the impression of dignity and clearness; but symmetry is not always attainable, and the skill of the bridge architect will then be the more needed to provide for an unsymmetrical structure an aesthetically satisfying appearance.

It is regrettable that many large bridge structures in or near cities have been built without sufficient regard for appearance and usually with the excuse that aesthetics cost money, and are, therefore, an unnecessary expense. This is not true in most cases. It is merely lack of study and skill in the designer, which is not creditable to the noble profession of engineering.

The engineer, whether he designs a bridge or a machine, should be more than a mere educated mechanic. He should cultivate an understanding for art, for refined taste in all things. Give me an engineer who has a discriminating taste in literature, a love for poetry and higher music, and that engineer will be incapable of inflicting upon his fellow-man the pain and nuisance of a mean and ugly structure in a city if he can avoid it. Let us learn in that respect from the ancients, who have shown a more ardent aptitude and a greater respect for everything beautiful. I maintain that only when the engineer shows an ability in his creative work to produce pleasing forms will he rise to that esteem to which his scientific education alone will not lift him.

Since the building architect does not include in his work the construction of bridges, and, on the other hand, the bridge engineer usually does not include in his studies the contemplation of pleasing forms, it should be the rule for any important, truly monumental bridge structure, that engineer and architect work together.

The greatest bridges are yet to be built. They will be naturally of steel. New York City has now the distinction of having the largest number of long span bridges, and it will have in all probability also the bridge of longest span anywhere, that over the Hudson River, which is only a question of time.

I do not intend to dwell here on the principles underlying the construction of very large bridges. If they were merely an expansion of the experience with ordinary spans, it would be comparatively easy to design them. I will mention only the condition of leading importance, which is that of determining accurately the weight of the structure itself. When this is done with the necessary caution and judgment, computations checked and repeated three to five times as needed of the entire structure and of every part of it, we have then the assurance of success and safety, as in the Forth bridge, the largest bridge at present in existence. When this is not done thoroughly, if the designer has more faith in mere figures than actual knowledge of stresses mathematically verified beyond the remnant of doubt, then we have a disaster as in the first Quebec bridge, which collapsed under its own weight before it was yet completed.

To the engineer whose business it is to build first of all safe structures, mathematics and the laws of statics are only tools which to use with skill and good judgment needs to be learned by experience as much as the sculptor has to learn the use of chisel and mallet, or even as the mere plasterer learns to use the trowel. Without skillful use of the necessary tools, learned only by experience, the engineer cannot any more safely design a large bridge than the most enthusiastic lover of art can create a beautiful statue, or than the plasterer can give a fine, even finish to a plastered ceiling.

Grade crossing accidents form a goodly proportion of the mishaps befalling automobiles. An investigation by a United States railway company showed that on its grade crossings 69.5 per cent. of the motor vehicle drivers looked neither way before crossing the tracks, 2.7 per cent. looked one direction only, and but 27.8 per cent. looked both ways. Reckless driving over the tracks was indulged in by 19.3 per cent. and only 0.2 per cent. stopped their machines before driving across.

Practical Methods of Measuring Flowing Water

The paper reprinted below, read by Mr. C. O. Wisler before the Michigan Engineering Society, is intended to synopsize the commonly used methods of measuring flowing water, drawing attention to those purposes for which each is particularly adapted. The paper follows:

Classification of Methods.

All methods of measurement may be divided into general classes, viz: (a) Direct discharge methods; (b) mean velocity-area methods.

The first of these two general classes includes all methods whereby the total discharge is determined directly, independent of any knowledge of the velocity or area of cross section, and embraces the following: (1) Gravimetric, (2) volumetric, (3) weirs, (4) chemical gauging.

In the use of the gravimetric method the total quantity of water flowing for a certain definite length of time is weighed; the total weight divided by the product of the weight of a cubic foot of water, and the length of observation, expressed in seconds, gives the flow in cubic feet per second.

In the volumetric method of measurement the total quantity of water flowing for a certain definite length of time is measured in a previously calibrated tank or measuring basin; this quantity expressed in cubic feet divided by the length of observation in seconds gives the rate of discharge in cubic feet per second.

These two methods obviously are unsuited for field practice, due to a lack of facilities for their use. They are mentioned here because they are the basic measurements to which many other methods are referred. In the hydraulic laboratory they are of prime importance.

Measurement by Weirs.

One of the oldest, usually most trusted, and for certain purposes most useful, methods of stream measurements is by means of weirs. A weir is a vertical obstruction placed in the steam bed containing a notch of either rectangular, trapezoidal, or V form, over which the water falls. In cross section of crest there are a large variety of forms, but for measurement of discharge the sharp-crested weir is used almost exclusively. Knowing the dimensions of the weir, the only observation necessary for the determination of the discharge is the head or the depth of water passing over the crest.

All this seems very simple. In the case of a small stream no difficulties are likely to be encountered in the actual construction of the weir, in obtaining its exact dimensions or in measuring the head of water over the crest. But when one comes to the selection of a formula to use in computing the discharge his troubles begin. In the different text-books on hydraulics may be found a varied assortment of formulae, all seemingly applicable to the kind of weir used.

In a case of this sort, before the engineer has gone very far he comes to realize that instead of the problem being simple it is really very difficult, providing, of course, that a high degree of accuracy is desired. It becomes necessary for him to determine the exact conditions under which the experiments were conducted which formed the basis for the development of the formula and the derivation of the coefficients; and, then, after he has done this, he must select that formula which is based on experiments conducted under conditions most nearly resembling his own.

For instance, one may expect to obtain very good results by the use of the Francis formula, making the proper corrections for end contractions and velocity of approach, providing he duplicates the conditions existing during Francis' experiments, as follows:

1. The weir must be sharp-crested and rectangular.
2. The distance from the end of the crest to the side of the channel must be at least three times the head on the weir.
3. The under side of the overfalling sheet of water must be subjected to full atmospheric pressure.
4. The height of the weir must be at least three times the head.
5. The head on the weir must be not less than 5/10 ft. nor much more than 1 5/10 ft.
6. The length of crest must be at least three times the measured head.
7. The velocity of approach must not exceed 1 ft. per second.

However, if any one of the above conditions be violated, the results obtained by the use of the formula will not be so trustworthy, and it may be advisable to use some other formula, provided one can be found that is based on experiments more similar to those in the case at hand.

Hence, the conclusion may be drawn that the reliability of weir measurements depends very largely upon the intelligence and skill employed in making measurements and computing discharges. If the conditions surrounding the original experiments are faithfully duplicated, then the results may be depended upon to be correct within 1 or 2 per cent. Under other conditions errors as great as 10 or 15 per cent. are easily possible.

It should be noted here that the place where skill is required in connection with weir measurements is in the installation of the weir and gauge. After this has been successfully accomplished, almost anyone with a little practice can read the hook gauge accurately enough for all purposes.

The principal application of the weir lies in the measurement of small streams or canals where the cost of weir construction is not excessive. It is also frequently useful in measuring the discharge from pumps, wells, or pipes, which are allowed to flow into a basin and then out over a weir. The advisability of its use in connection with turbine testing is open to question. In this class of work the highest possible degrees of accuracy is desirable, and, in the opinion of many, this is best obtained by the chemical method.

Chemical Gauging.

The most recently developed and, for certain purposes, most important of the direct discharge methods of measurement is by the chemical process. The principle involved in this method is very simple. Briefly, it consists of adding to the stream at a certain definite rate some chemical, usually salt, on account of its low cost. Then at some point down stream, after a uniform mixture has been effected, samples are drawn off and the degree of dilution is determined. If w pounds of salt be added to a stream whose discharge

is Q cubic feet per second and after a thorough mixture it is found that n pounds of water contain one pound of salt, the total discharge Q in cubic feet per second will be equal to wn/62.5. The success attained by the use of this method depends primarily on the skill of the observers. Two important points should be considered:

First.—The chemical must be added at an absolutely constant rate. This is usually accomplished by delivering a concentrated solution to the stream through a small orifice under a constant head. Due to the high specific gravity of the solution the rate of discharge through the orifice cannot be determined by ordinary formula, but must be found by measuring the quantity discharged in a given period.

Second.—A thorough, uniform mixture of the chemical with the stream must be secured before samples are taken. The length of time required to secure this mixture can be determined by taking a number of samples at different points in any cross section and determining the variation between them. If they do not vary by more than 1 per cent. in the amount of chemical contained the mixture is usually considered satisfactory. Mr. Parker, an English engineer, and one of the pioneers in the use of this method, has formulated the following empirical rules. If V represent the mean velocity of the stream and b the breadth, then, when the average depth lies between 1/10 b and 3/10 b, complete mixture occurs at a distance down stream equal to about six times the width of stream and at a time when the addition of the chemical has continued for at least $\frac{24b}{V}$ seconds. Also sample must not be taken more than $\frac{6b}{V}$ seconds after the addition of the chemical has ceased.

Applying these rules to a stream whose width is, say, 50 ft., average depth 6 ft. and mean velocity 3 ft. per second, the samples should be drawn off at a distance of 300 ft. down stream and not until the addition of the chemical has continued at least 400 seconds, or nearly 7 minutes. Furthermore, it would be safe, according to this rule, to draw off samples for 100 seconds, or 1 2/3 minutes, after the addition of the chemical has ceased.

However, attention should be called to the fact that these rules are applicable only to streams whose average depth is at least one-tenth of the width, and streams of this sort are not very common in this country. Consequently, it would seem that in applying this method of measurement to a wide, shallow stream, like the Grand River or the Huron, the best way of determining the proper point for sampling is by trial. That is, go down stream a distance of, say, six times the width, and by taking a number of samples throughout the cross section, determine if the degree of dilution varies by more than 1 per cent. in the different samples. If it does, then go farther down stream until a point is found where it does not.

However, the most useful application of the chemical method is not in gauging wide, shallow streams. Such streams can perhaps better be measured by the aid of current meters. But for turbine testing or for gauging rocky, turbulent mountain streams, where a thorough mixture is readily obtained, it is extremely doubtful if any other known method of measurement can compare with this in giving accurate, trustworthy results. In a series of turbine tests at Massena Springs, N.Y., conducted under the direction of Mr. Benjamin F. Groat, consulting engineer for the Aluminum Company of America, five successive tests under exactly the same conditions checked each other within 1/10 of 1 per cent. Of course, it is possible that a constant error affected all the results alike; but, considering the great amount of care exercised in carrying on the experiments, this hardly seems likely, especially when a number of other experimenters have conducted tests of a similar nature which checked within ½ of 1 per cent.

Mean Velocity-Area Methods.

This brings us to a consideration of the second class of flow measurements, viz., those accomplished by determining the mean velocity and cross sectional area of the stream. Knowing these two qualities, their product gives the discharge. This class of measurements naturally subdivides itself into two groups. The first group comprises those methods whereby the mean velocity of the whole stream is determined directly by one operation, as is done in measurements made by Venturi meters, moving screens, slope determinations, orifices, nozzles, and the like, and by the color method. The second group includes those methods whereby the total cross section is subdivided into sections whose area, mean velocity, and discharge are determined separately, and these discharges summed up to give the total discharge of the stream. The methods falling under this second group differ only in the manner of determining the mean velocity of the sections, and comprise the use of surface floats, rod floats, current meters, and Pitot tubes.

Consideration of Methods of the First Class.

The methods of measurement falling under the first subdivision have a very wide range of application and a corresponding range of reliability.

Orifices, nozzles, short tubes, and the like are generally used only in the measurement of small quantities of water. A sharp-edged orifice with an area of 1 sq. ft. or less furnishes a very reliable means for measuring the discharge from a tank or reservoir providing only that the head be relatively high and the velocity of approach low. However, a thorough knowledge should always be had of the conditions surrounding the original experiments upon which are based the determination of the coefficients used. For orifices with an area of more than 1 sq. ft. the coefficients have not been reliably determined.

Velocity determination by the use of a traveling screen is comparatively new. The screen is usually made by stretching canvas on a light frame. This is suspended from a wheeled carriage, which runs on a track, either over or at the side of the channel. By observing the time required for the screen to move a certain distance the mean velocity is at once determined. It is apparent that this method is restricted to open channels of very regular cross section. The cost of equipment is high, and the method is seldom used, although under ideal conditions it provides a means of obtaining very good results.

Measurement by slope determination and the use of the Chezy or experimental formula can be relied upon to give only roughly approximate results. Sometimes, however, this is the only method that can be employed, as, for instance, in estimating a flood that has already passed by. If high water marks can be found, as is usually the case, the slope of the stream when the flood was at its peak can be determined by the aid of a level. The mean hydraulic radius, which is the area divided by the wetted perimeter, can also be found by measurement. Then, by a proper exercise of judgment, coupled with a semi-divine know-

ledge of the correct value of n to use in Kutter's formula, the mean velocity can readily be determined from the formula

$$V = C\sqrt{RS}$$

Unquestionably the Venturi meter provides the most reliable means at the municipal or sanitary engineer's command for the measurement of the velocity of water in pipes flowing under pressure. This instrument consists of a special casting which is inserted in the pipe line. In appearance it resembles two nozzles with their small ends joining, the larger end having the same diameter as the pipe line. The principle involved in the use of the instrument is based on Bernoulli's theorem, a discussion of which, along with formulae for the use of the meter, can be found in any text-book on hydraulics. By obtaining the difference in pressures at the throat and at the inlet with the aid of piezometer tubes the velocity can be determined. With a properly calibrated instrument the results should be very accurate, possibly with an error of less than 1 per cent. By the use of a recording gauge in connection with a Venturi meter continuous reliable records of discharge can be obtained with very little effort. Practically the only objection to its use is its cost, as it is rather expensive. However, the first cost is practically the whole cost, and as the instrument is usually used only as a permanent installation where either continuous or intermittent records extending over a period of time are desired, this item should not, in the end, prove objectionable.

(To be continued.)

Timber Conservation by Electricity

A new process has been discovered for drying and conserving timber which is being tried in Europe with a great deal of success. The "Nodon" process, as it is called, makes use of electricity. A strong electric current passes through freshly-cut wood appears to cause a chemical change resulting in oxidation of certain parts, together with a physical change in the cellulose. On account of this, the wood is better preserved against the action of fungi and is more suitable for mechanical use. It is said that in a few hours a thorough oxidation of the wood sap takes place by this process, which ordinarliy requires several months in free air. The method can be so successfully applied to green timber that it is thoroughly seasoned in a few weeks. The moisture in the wood helps to carry the electric current and hence, when the process is applied, the timber should not be too dry—in fact immediately after cutting is advisable. The electrical energy required is 3 to 6 kw. per cubic yard.

At the annual meeting of the Ontario Municipal Association, held in Toronto, the association approved of the removal of duty, excepting war tax, from imported paving brick. This was the outcome of a letter addressed to the Association by Mr. F. B. Goodman, who stated that since there are no paving brick manufacturers in Canada the removal of duty would not injure the industry in any way. The Association approved of the principle involved in the statements contained in this letter, and therefore passed the resolution spoken of, but they recommended that the letter be referred to the Good Roads Association for consideration, feeling that its members would be interested in this matter.

The highest bridge on the Grand Trunk Pacific Railway system is that over Pembina River, 860 miles from Winnipeg. This bridge is 208 feet high.

A Cleverly Designed Steel Tank

The accompanying photograph illustrates a large elevated water storage tank built for the Campbell Flour Mills Company, Ltd., of Toronto, Ont. Their flouring mills, which rank among the most progressive in Ontario, were recently equipped with an automatic sprinkler system, to provide fire protection and reduce their insurance rates. The tank is used for the storage of water necessary to operate the sprinkler equipment satisfactorily. The prominent position and great height of the structure renders it peculiarly effective for advertising purposes, and the company has taken advantage of this fact in having the tank built in replica of a bag of flour. The work is built entirely of steel, which material may be readily formed to the shape desired and at the same time insures great strength and unusually long life. The tank was painted and lettered to exactly represent the sack in which the company's product is marketed. Some idea of the size of this water tower may be gathered from the following data: The tank holds 40,000 gallons of water. The total height of the structure is 152 feet above foundations. The tank itself is 37 feet deep and 18 feet wide, being built oval in cross-section, to correspond truly to the shape of a flour sack. The weight supported is over 200 tons.

This Novel Water Tank is an Effective Advertisement.

The work was designed and executed by the Canadian Chicago Bridge and Iron Company, of Bridgeburg, Ont., which makes a specialty of this class of construction. They have also recently constructed in the city of Toronto for the City Dairy Company a similar structure, having the tank in the shape of a milk bottle.

Messrs. Oborn & Ellis, architects, Lumsden Building, Toronto, have moved to new quarters at No. 22 College Street.

W. C. E. Koch Flume—Note sweeping vertical and horizontal curve, with change of grade, also piling and pole bents.

Adams River Lumber Company Flume—Junction of a feeder with main flume.

Milwaukee Land Co. Flume—Note 20 degree reverse curves at bottom of 17 per cent. grade.

Crows Nest Pass Lumber Co. Flume—Note creek cross rig and cribbing along banks of creek to prevent washing out of foundation.

Flumes for Logging Operations

In lumbering operations, water is extensively employed in some manner for carrying logs, timber, or other forest products from the point of cutting to the mills and factories. The most commonly used method is to float the logs in a running stream to the manufacing plant, a process known as log-driving. However, as the forests lying along these streams are being cleared, such a process becomes less applicable and new methods must be sought, if many large and valuable tracts of the finest kind of mercantile timber are to be made available. Railroads have been extensively built for this purpose, and prove of advantage when their location in a forest area is practicable. In many cases conditions of grade or considerations of cost prohibit developments of this nature.

Under such conditions flumes have successfully solved the difficulty and have proven eminently satisfactory as well as reasonable in cost. The illustrations reproduced herewith show typical flume constructions, and indicate the general schemes adopted in such a method of transporting timber. The only condition required for successful operation of logging flumes is that there is a sufficient supply of water that can be diverted into the channel at such an elevation as to ensure flow to the point of delivery.

Flumes have special advantages in being flexible as to curves and grades. The grades on which a flume can be built and operated can be as steep as 25 per cent. at least and as flat as one-tenth of one per cent. It is not essential to have uniform grades, as it has been found that changes of grade from one extreme to another can be efficiently carried out. The curvature depends on a number of variable conditions, curves of 20 degrees being quite common.

Flumes are also easily constructed over extremely rough, rocky, or broken country by trestling. In this respect they can be installed where railroad locations are impossible. The trestle work on which they are generally built adapts itself readily to a great variety of ground conditions.

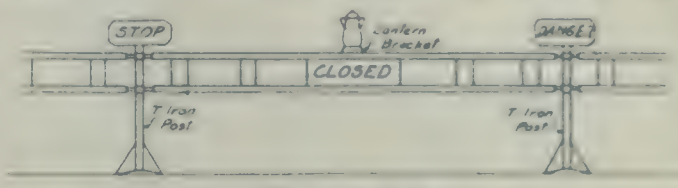
The practicable length of a flume depends on the limitations of the water supply and on the maintenance of a descending gradient. There are known cases of flumes 30, 40, and 50 miles long that are in successful operation.

The maintenance cost of wood flumes is surprisingly low, and it can be safely assumed that the life of a well-constructed work, kept in repair, will be at least twenty years. The only wear occurs in the flume box, which can be maintained at comparatively little expense.

The illustrations show the general schemes adopted, and portray the curvatures and grades that may be accommodated. The flume box itself is triangular in shape, as this has been demonstrated to be the most efficient and desirable in operation. The sides are inclined at 45 degrees. This angle carries the water around curves with the least disturbance and slopping.

Metal Road Blockade

The accompanying sketch illustrates a metal road or street barrier which has been designed to replace the old wooden type which is not only unsightly but is easily broken, laid aside or carried away. This new device is manufactured entirely of metal and is light, strong and unbreakable. It consists of channel bars fitting over arms on the supporting T-iron posts and held by pins or bolts, if necessary. The barrier is thus

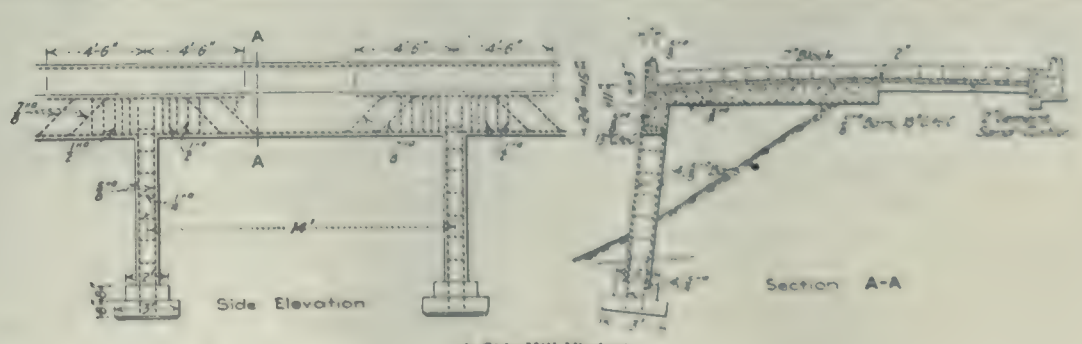


A street barricade made of metal.

very easily assembled or taken apart and can be extended indefinitely. The posts are 36 inches high and weigh 14 pounds each, and the barrier part is made in 10 foot lengths, weighing 24 pounds. Red painted signs 9 in. by 15 in. with black lettering are provided as shown and the device is furnished with a lantern bracket arranged for a padlock to prevent theft. This road blockade is manufactured and sold by the C. C. Fouts Tank and Silo Company.

Side Hill Viaduct

Much trouble is often experienced with roads running along a line of fill by settlement or down-hill slipping of the fill face, causing cracks in the road surface or even cave-ins. The method of overcoming this in one particular instance was to use a side-hill viaduct, a construction rarely employed on this continent. The illustration shows in diagrammatic form the essential features of a side-hill viaduct as applied to the case in question, the structure being of reinforced concrete. Columns are spaced at intervals along the road with longitudinal girders resting on top and a flat reinforced slab spanning from this girder to a bearing on undisturbed ground near the centre of the road. The road surface is then built on top. This method has been found to be a very effective cure for a slipping fill.



A Side-Hill Viaduct.

Rideau River Irrigation Scheme

Cornwall, Ont., Sept. 2, 1916.

Editor Contract Record:

I read with much interest the "Rideau River Irrigation Scheme" in your issue of August 9, illustrated with a map, which is correct so far as my knowledge of this scheme is concerned, but the basic principle that the country requires irrigation is fundamentally wrong, and it is only necessary for you to consult the drainage engineer at the department in Toronto to find out the vast sums being spent to drain the area, even in the neighborhood of Ottawa.

What is a far more feasible scheme is for the Government to assist the farmer in draining all of the said area, to reclaim the land rather than to irrigate.

Yours truly,

A. Jas. Milden.

All-Steel Portable Buildings

There is a special field for the use of steel, portable buildings for constructional or other temporary purposes. For contractor's offices, draughting rooms, workshops, tool rooms, or other similar uses in connection with the erection of buildings, metallic, portable designs have been developed that are especially advantageous. In the past wooden structures have been erected for this purpose, but in many cases after the need for their use has disappeared, the lumber used in their construction is waste. On the other hand, metallic buildings of the types now on the market are permanent investments, since they are portable and can be re-erected on any desired location at any time.

These buildings are now being made by various manufacturers of pressed steel in collapsible sections that have been standardized. These come delivered in crates, and can be unpacked, placed in position, and wedged together with astonishing rapidity, a few men being able to erect a building complete in the matter of only a few hours. The resulting structure is sound and strong, wind-proof, fireproof, and weather-proof, making a thoroughly comfortable interior.

The makers of these pressed steel units are producing products of pleasing appearance with panelled or decorated exteriors, affording a very grateful relief to the eye accustomed to the uncompromising plain surfaces usually found in temporary structures. Skilled labor is usually not required for the erection of these buildings, nor are special tools necessary. Foundations also are rarely obligatory, in most cases sleepers being adequate.

May Build $1,000,000 Bridge at Buffalo

The U. S. House of Representatives August 29 granted permission to a committee of nine citizens of Buffalo, N.Y., to construct a toll bridge across the Niagara River in or near that city. The proposed structure will cost about $1,000,000.

New Books

The Construction of Roads and Pavements—by T. R. Agg, C.E., Professor of Highway Engineering, Iowa State College; McGraw-Hill Book Company, Inc., New York, publishers; price $3.00; written to present in concise form the latest approved practices in the construction of roads and pavements and the principles involved. Intended primarily as a text-book for a short course in roads and pavements, but numerous tables and typical designs and specifications have been included. This book should be found of great value to anyone interested or engaged in the work of highway construction or maintenance. The ground covered may be judged from the following chapter headings: The Development of Highway Systems; Surveys and Plans for Roads and Pavements; The Design of Rural Highways; The Construction and Maintenance of Earth Roads; Testing Non-bituminous Road Materials; Sandy-clay Roads; Gravel Roads; Water-bound Macadam Roads and Pavements; Concrete Roads and Pavements; Vitrified Brick Roads and Pavements; Wood-block Pavements; Stone-block Pavements; Bituminous Road and Pavement Materials; Dust Layers and Bituminous Carpets; Penetration and Mixed Macadam Roads and Pavements; Sheet Asphalt and Asphaltic Concrete Surfaces; Selection of Type of Surface for Rural Highways; Selection of Type of Pavement Surface; The Design of Pavements; Tests for Bituminous Road and Paving Materials. Well illustrated; size 6 x 9 inches; stiff cloth covers; 425 pages.

Mainly Constructional

East and West—From Coast to Coast

The Halifax, N.S., Automobile Association are advocating, and have prepared cost estimates, for the construction of 1,500 miles of good roads in that province.

A recommendation that the roadway to the Hamilton Sanatorium be reconstructed has passed. Work will cost $2,975 and will be commenced almost immediately.

The Wailamette Iron and Steel Works have registered to carry on business in the province of British Columbia. The head office of the company is situated at 1104 Standard Bank Building, Vancouver.

The Board of Health, Hamilton, Ont., advertised for men to tear down the old incinerator building on Wellington Street but as no replies were received it was decided to give it free to any person who would remove it.

Building permits for all Canada during August were $4,254,691. This amount exceeds the total for the same month last year by $1,197,701, or almost 100 per cent. The total for the year to date is $23,362,460, or an increase of $3,143,841,

While ante-bellum building conditions in St. John, N.B., have not yet returned, figures show that building is on the increase. The value of permits from January 1 to August 31, 1916, amounted to $343,000; corresponding period last year, $218,800.

Bathurst, N.B., which recently installed a new water system, is now to have a flour mill. It will be operated by the George Eddy Company. The buildings are now being erected. In addition to grinding home-grown wheat, it will be used for grinding western grain.

A supreme court writ has been filed by David Gibb against the Northern Construction Company, Limited, and others, alleging breach of contract relative to the supplying of Saturna Island stone for the building of the Canadian Northern depot at False Creek, B.C.

The Western Machinery Works, Limited, Vancouver, B.C., have been incorporated. The company will manufacture and repair gasoline, steam and other kinds of engines and machinery, automobiles, motors, flying machines and other articles capable of being manufactured from metal.

At a recent meeting of the Nova Scotia Steel and Coal

Company it was stated that the company had sufficient business now on hand to keep every furnace and mill employed for more than twelve months. The directors agreed to subscribe for $250,000 worth of the new Canadian War Loan.

License has been issued under the Great Seal of the Province of Ontario, authorizing the Dominion Fire Proofing Company, Limited, a corporation created by or under the authority of the laws of the Province of Manitoba, to deal in brick, tile and fire proofing products, and to carry on the business of contractors and builders.

Some 250 members of the Canadian Society of Civil Engineers were present as guests of the Dominion Bridge Company on the day set for the placing of the big centre span of the Quebec bridge, which should have been the culmination of one of the world's greatest engineering feats, but instead proved a deplorable disaster.

An increase of close to $100,000 in building permits is shown in the Chatham, Ont., figures for the first eight months of the year as compared with the same period last year. In addition it is expected that the permit for a plant for the Dominion Sugar Company will be taken out shortly, which will bring the present total of about $243,849 up to nearly $1,000,000.

Mr. Brummel, of East Trenton, Ont. it is stated, has just completed a new type of boat for carrying freight. The boat from outside appearances looks like a huge scow. It is to be run by two twenty-four horsepower gasoline engines, operating two propellers, and has a capacity of 600 barrels of apples. It was built for navigation purposes on the Trent Valley Canal.

It is reported that the next move of one of the great automobile manufacturing companies will be to organize its workers into four shifts, each working six hours, without interruption for meals. The men are to be paid $1 an hour. This will keep the plant running a full twenty-four hours, which is not practicable with the eight-hour shift on account of the intermissions for meals.

The breaking up of the macadam roads in Welland County, Ont., has been subject of much discussion by the county council. The majority were of the opinion that macadam was not a sufficiently permanent material. Some, however, believed the deterioration was due to the heavy motor traffic coming on the roads before the pavement had time to become solid. The use of oil to preserve the roads was suggested.

Building permits and customs receipts at Welland, Ont., for the month of August, both more than doubled the totals for the same month last year. Customs receipts for August, 1916, totalled $63,289. Last year the total was $29,937. Building permits for August, 1916, were $25,648, as compared with $12,147 for the same month last year. Industrial conditions are reported in excellent condition but a scarcity of labor is noticeable.

It appears that the plans for the construction of the administration building at the Agricultural College at Winnipeg, Man., were changed after the letting of the contract, from evidence given before the Galt commission. The plans on which the $229,000 contract was let called for reinforced concrete and steel floors throughout the building, on March 3, 1911, but on April 1 following, new plans were adopted which called for steel and tile floors.

Many houses visited by the St. John, N.B., plumbing inspectors have been found defective and notice has been served on the owners to make the necessary repairs within ten days or water will be shut off. Detecting leaks and dripping faucets, it is said, has been greatly facilitated by the use of the sonoscope, an instrument very similar to a telephone receiver, which, when placed on a pipe, at once reveals whether the pipe is free from leaks.

The contract for the Aylmer, P.Q., filtration plant to be built of concrete, has been let to R. C. Smith & Co., of Montreal, at $36,512. The system is to be of the rapid sand type, with New York Continental Jewell Filtration Company's equipment. The capacity is one million Imperial gallons. There are to be three filters, each 125 feet square, the clear water basin containing 40,000 gallons. The coagulation period will be four hours. Mr. J. O. Meadows, Montreal, is the consulting engineer.

Answering a rumor that work on the Welland Canal and the Ottawa Parliament Building was to be suspended until after the war, Hon. Robert Rogers, Minister of Public Works, declares it to be "rot." Work on the Parliament Building is in full swing, with night and day gangs, and will continue. To discontinue work on the Welland Canal, he pointed out, would leave the Government liable to heavy damages to the contractors, who have thousands of dollars tied up in plants, machinery, etc. The Minister also declared that the Toronto Harbor works will be continued as planned.

Harbor development enterprises are being vigorously pushed at both west and east St. John. On the west side, the Maritime Dredging Company and the Canadian Pacific Railway Company are engaged on reclamation contracts in connection with the new pier system that is being developed there. The fulfilment of these contracts will give the port another large concrete pier for ocean craft, besides a more extended yard space for the handling of freight. One feature of the C. P. R. work is the erection of a 20,000 gallon reservoir to supply fresh water for engines and cars. At West St. John, the finishing touches are being put to the 4,500 foot breakwater, almost the entire channel of 10,000 feet has been dredged to a width of 500 feet and a depth of 32 feet, one-half of the interior basin has been dredged to the same depth, two pier sites are well advanced, and excavation is being rushed on the dry dock site.

Personal

Mr. David W. Johnston, engineer for the South Saanich Municipality, New Westminster, B.C., has announced his intention of enlisting for overseas service.

Mr. Charles J. Barr, formerly general superintendent of the Tennessee Coal, Iron and Railroad Company, Ensley, Ala., has been appointed general manager of the Algoma Steel Corporation. Mr. Barr is a Canadian and belongs to Lindsay Ont.

Obituary

Mr. George Forsythe, at one time a prominent contractor, in Toronto, is dead at the age of 72 years. The late Mr. Forsythe latterly travelled Ontario as an insurance valuator but also did building and contracting work on many of the city's oldest buildings.

Mr. J. H. Leahy, contractor, died recently at the Royal Victoria Hospital, Montreal. Mr. Leahy had been associated with works in that city for many years. He had the contract for the paving of Notre Dame Street through Maisonneuve and for the construction of many city drains and sewers.

Mr. John Bannerman, a well-known resident of Ottawa, passed away recently, following an operation. He was born in Scotland 66 years ago and came to Canada at an early age, settling in Ottawa, where he has resided ever since. Formerly he was a member of the firm of Powers and Bannerman, and was the constructor of the first pipe for the Ottawa Waterworks system.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Aylmer, Ont.
The Town Council have decided to lay a tile drain on Elk Street. Engineer, F. Bell, Court House, St. Thomas.

Hepworth, Ont.
Plans have been prepared for sewers to be constructed for the Town Council at an estimated cost of $3,170. Clerk, W. R. White.

Leamington, Ont.
The Town Council propose to replace the existing 2½-inch watermain with 4-inch. Engineer, J. J. Newman, Ouellette Avenue, Windsor.

London, Ont.
Plans are to be prepared for the construction of a sanitary sewer system in south-east London, estimated to cost $100,000, and work will start this fall. Engineer, H. A. Brazier, City Hall.

Malden Township, Ont.
George Anderson, Amherstburg, proposes to construct a large amount of tile drain on his property, and is preparing plans.

New Glasgow, N.S.
Tenders will be called shortly for the construction of waterworks additions for the Town Council, estimated to cost $100,000. Engineer, E. S. Fraser.

Osnabruck Township, Ont.
The Township Council are considering the enlarging of Hootle Creek in order to drain about 40,000 acres, and have instructed the Engineer, J. A. Milden, care of the Township Clerk, to prepare plans and estimates. Clerk, H. E. Hodgins, Farrans Point, Ont.

Ottawa, Ont.
The Dominion Government Department of Public Works propose to repave Wellington Street at an approximate cost of $70,000. Secretary, R. C. Desrochers, Ottawa.

Sherbrooke, Que.
The Waterworks Committee are considering the installation of a vertical plunger pump, with a capacity of 4,000,000 gallons. Secretary, E. C. Gatien, City Hall.

CONTRACTS AWARDED

Aylmer, Que.
The general contract for construction of a filtration plant for the City Council has been awarded to R. T. Smith, Westmount, Que. Approximate cost, $25,000. The contract for equipment has been let to the New York Continental Jewell Filtration Company, 10 Cathcart Street, Montreal.

Dover Township, Ont.
The Township Council have awarded a contract for the construction of concrete sidewalks to John Tewkesbury, Lacroix Street.

Hull, Que.
The City Council have awarded the contract for laying watermains to Wilfred Hebert, Wall Street. Pipe will be supplied by the City. Estimated cost of work, $35,000.

Niagara Falls, Ont.
The City Council have let a contract for the construction of sewers to Louis Sacco, Niagara Falls South, at $3,585. Engineer, W. Jopson.

Sault Ste. Marie, Ont.
The City Council have awarded a contract for construction of cement walks to A. R. Wood, 136 Pilgrim Street.

Trenton, N.S.
The Town Council have awarded the contract for construction of concrete pavement on Main Street to Fage & Lusby, Amherst, N.S., at $32,000.

Railroads, Bridges and Wharves

Essex County, Ont.
The County Council propose to spend $25,000 on the construction of bridges. Clerk, W. P. Coyle, Sandwich.

Scarboro Township, Ont.
The Township Council propose to replace Smith's Bridge on the Fifth Concession, South of Unionville, with a concrete structure. Clerk, W. D. Annis, Scarboro.

Thistletown, Ont.
The Etobicoke Township Council, Islington, are considering the erection of a bridge to connect Baker Avenue with Concession A.

Tillsonburg, Ont.
The Grand Trunk Railway are considering the erection of a steel bridge over Broadway. Particulars from Superintendent Davidson, London.

Vancouver, B.C.
The general contract for the construction of the Coal Harbour sea wall and sewer has been awarded to the Cotton Company, Limited, False Creek, Vancouver, and the contract for dredging and back-filling to the Dominion Construction Company, 509 Richards Street, at $16,962.

The Canadian Pacific Railway have awarded the contract for dredging and gravel fill required in the construction of Pier B to W. D. Grant, 503 Burrard Street.

Public Buildings, Churches and Schools

Beamsville, Ont.
Tenders on the erection of a High School according to the revised plans will be received until September 27th. Architect, W. W. Lachance, 157 Main Street, Hamilton. Approximate cost, $20,000.

Colinton, Alta.
Tenders on the erection of a frame school will be received until noon, September 30th, by the Trustees of School District No. 3169. Plans and specifications at office of the Secretary, Albert Gyte.

County Line, B.C.
Tenders on the erection of a school will be received until noon, September 25th, by J. E. Griffith, Deputy Minister of Public Works, Victoria. Plans and specifications at offices of J. Mahony, Government Agent, Court House, Vancouver; F. C. Campbell, Government Agent, Court House, New Westminster; J. W. Berry, Chairman of School Board, Langley; and at the Department.

East Selkirk, Man.
E. D. Little, 705 McArthur Building, Winnipeg, has been appointed architect for the school to be built for the Happy Thought School District. Approximate cost, $8,000.

Lennoxville, Que.
K. G. Rea, Beaver Hall Hill, Montreal, is preparing plans of a school for the Corporation of Bishop's College School.

Medicine Hat, Alta.
The tenders received for the erection of a public school were too high, and the architect has been instructed to modify the plans so as to bring the cost down to about $15,000.

Montreal, Que.
The tenders received for the erection of a church for the Parish of Notre Dame of the Holy Rosary of Villeray were too high, and the work will be done by day labor. Architects, Viau & Venne, 76 St. Gabriel Street.

Tenders will be received until 4 p.m., September 26th, by R. C. Desrochers, Department of Public Works, Ottawa, for the installation of a freight elevator and alterations at Postal Station A. Plans and specifications at office of the Overseer of Dominion Buildings, Central Post Office, and at the Department.

Sherbrooke, Que.
Tenders on the erection of an extension to the Nurses' Home for the Sherbrooke Hospital Board will be received until September 25th by the architect, H. G. James, Whiting Block. Brick construction. Approximate cost, $20,000.

Strathroy, Ont.
The Strathroy Hospital Board are considering the erection of a Nurses' Home, at an estimated cost of $3,500. Particulars from T. N. Dunn.

West St. Paul, Man.
A by-law has been passed for the erection of a Municipal Hall at an approximate cost of $5,000, and tenders may be

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The Engineer and Political Life

IT has been repeatedly pointed out that engineers as a profession do no publicly interest themselves in the political life of their communities. Perhaps owing to those very qualities of modesty and thoughtfulness that are characteristic of the man with a constructive mind, they refrain from entering into the realms of public life. They seemingly do not care to become involved in the discussions and criticisms that are inseparable, apparently, from political offices. For these reasons it is a rare occurrence to find an engineer occupying a high and influential position in the community or nation. And yet these are the very men who should take most interest in the political life of their country. They are the men of all men who have built up its resources, developed its wealth, promoted its manufactures, enlarged its markets. It has been the duty of our engineers to take what natural sources of wealth we have, and by planning and constructing our great systems of transportation, erecting our industrial plants, harnessing our water powers, and providing our machinery, to build up what greatness we may possess. Engineers have done all this, and yet rarely are they seen in those executive positions where they may direct the results of their handiwork.

Engineers, perhaps, lack the aggressiveness of those other types of citizens who from sheer push—or pull—reach the high offices that public or private life has to offer. It does not require much investigation to show that lawyers, for example, have enthroned themselves in positions of influence and dignity. Lawyers are found as the mayors of our cities, members of our commissions, ministers of our provinces, premiers of our nation. They have given themselves these places by virtue, not necessarily of their ability, but of their intermingling with the political life of the day, of their entering into the discussions and problems of civic or national importance.

* * *

Yet engineers, whose profession is a symbol of public service, whose work is intended only to embody the principles of science, uninfluenced by the thoughts of political graft or popular gain, should be as capable in the high offices as the members of the legal profession. Just trying to build things honestly, strongly, and straightforwardly is the engineer's business, and a little more of this same spirit and influence in politics would solve many governmental problems. There seems to be all too little of the unselfish in our public administration, too much of the spirit of equivocation. It is not saying too much for the engineering profession to suggest that its members can help to provide a solution for such problems. The community would benefit greatly by the entrance of the engineer into its problems and difficulties. Frequent remarks are made that the best qualified citizens do not attend properly to their political duties, and from this point of view alone it would be wise to educate the engineer to do his share.

Without in any way deprecating the valuable work that lawyers have done in the way of public service, yet it would not be without benefit for engineers to replace to some extent many lawyers in public places, because their aspects and viewpoints materially differ. The lawyer is essentially a critic, an analyst, while the engineer is constructive, a planner, a builder, and his very familiarity with those essentials of national development equip him for a higher place in the evolution of a democratic nationhood.

* * *

An interest in politics on the part of the engineer would benefit not only the nation, but also himself. By familiarizing himself with the machinery of popular government, by striving continually to discuss and solve the political problems and programmes he would be developing those close and friendly relationships with men of other outlooks in such a way as to promote broad-mindedness and permit him to meet men on their own ground. The enlarged acquaintance would make him quick and accurate in judging men and adapting himself to any situation, besides enabling him to popularize his technical and scientific knowledge. Undoubted benefits would accrue to him personally.

There is no doubt but that the majority of engineers think over the political questions and suggest solution in their own minds. They cannot help but do this, as they are constantly in contact with these problems and with the men who are bringing them up.

However, there seems to be an inborn tendency to keep these thoughts secret. Engineers do not, as a rule, admire publicity, and for this reason keep themselves apart from political and governmental life. But, as we have tried to point out, such benefits will accrue, personally and generally, that we would urge engineers, as a profession, to shed this cloak of modesty and realize that patriotism, devotion, and foresightedness should require them to adopt a truly national spirit.

Organized Advertising Pays

IN an editorial office there is unexcelled opportunity for studying the trend of the technical mind as exhibited and exemplified in the pages of contemporary journals, and it has been a matter of observation for some time that, in a majority of the exchanges, publishing matter of supposedly general interest, a very large proportion of the articles are devoted to describing concrete and its application in some form or another. The Contract Record has always, we believe, endeavored to avoid this exclusiveness by showing a broad interest and by developing, as far as possible, the engineering and contracting field in all its branches. This magazine aims to divide its pages in a fair measure among the various constructional interests without attempting to emphasize to too great an extent any particular branch. The fact remains, however, that our contemporaries show a prevailing tendency to specialize on concrete, and to such an extent that it is probably safe to state that more space is devoted to the study of this material than to all the other structural products or methods added together.

There is, no doubt, a definite reason back of this. In searching for an explanation we have come to the conclusion that this condition merely indicates the channels along which men's thoughts are being directed. It is an accepted principle that the press expresses public opinion, and a technical journal, of necessity, treats of those matters in which its readers are most interested. If the majority of the articles extol the virtues of concrete, it is an indication that the majority of readers are looking for information about this material. It proves that for some reason concrete is uppermost in the mind; that it occupies, for a time at least, a pedestal in public thought and interest.

Certain conditions are undoubtedly operating to produce such a result—a result which, on the surface does not seem fair, perhaps, to the manufacturers of those other products that are just as favorably associated with engineering and contracting projects. Concrete is a new material. It is universally employed; its use is almost unlimited; its application unrestricted; it is a substance that appeals to the people because the people can handle it. Does not this universality explain in a certain way why technical pages abound with matter regarding it? The very fact that concrete is new and even yet in an experimental stage seems to provide a certain justification for giving it greater consideration. It is merely a case of more thought being given to concrete than to anything else, and these ideas give way to words in the editorial columns.

To account for this public attitude, however, a possibly stronger reason has impressed itself upon us, and this is the active campaign that the cement manufacturers are carrying on. The Portland Cement Association, for example, have been placing their product prominently before the public by a strenuous publicity and advertising campaign. A series of booklets and pamphlets issued by this association has been widely reproduced. The work of this organization has undoubtedly contributed to the extensive use of this material, and has directly or indirectly affected the policy of many technical journals. Such advertisement creates a demand and an interest in the product that cannot possibly result from mere merit alone without the aid of publicity. The cement manufacturers early realized that if concrete, new and untried as it was, was to attain any measure of success in the face of the competition of well-established and successful structural materials, an energetic and strenuous organization must be established to impress the public with its advantages.

On the other hand, we feel that the lack of information in regard to other materials is due in no slight degree to the evident lack of a similar campaign on the part of such people as the brick, the tile, the metal manufacturers, and so on. Any associations that these interests may have are not making themselves felt; they are engaging apparently in no active or extensive publicity or advertising campaigns like the Lime Bureau or the Cement Association. It may be that they feel that they represent industries well established which require no public advertising, but now, as always, union is strength, and the example of the cement makers is only an indication that a similar plan would produce results in other lines, and that it would be none the less effective and prolific.

To show to what extent the cement people are willing to go, we are informed that a prominent Canadian cement manufacturing firm intends to build a model concrete road at its own expense, the object being, no doubt, to show antagonists how perfect a road can be built of this material, to counteract a prejudice that has been created by virtue of a number of such road failures. This corporation is willing to stake a large sum of money if by doing so it can attain an object that will repay manifoldly by creating a demand for such roads. Where are the brick manufacturers? Why do they not take advantage of the failures and defects of concrete? The reason is that they do not appear to possess an organization that is effective in furthering their interests. They are dormant and inactive. We are not desirous of deprecating the popularity of concrete, but our object is to suggest a remedy for the disadvantage under which the brick, steel, and iron interests are laboring.

We throw this out by way of suggestion, so that it might meet the eyes of those who feel that concrete is receiving more than its due share of editorial comment. Let the manufacturers in whatever field they may operate, create such associations or bureas as will foster their wares and their advantages, and we feel sure that the technical press will co-operate to the fullest extent.

Contractors Lose Valuable Mixing Plant

An unfortunate mishap occurred on September 14 at the St. Charles River improvement work, when a scow with a complete concrete-mixing outfit on board capsized. The equipment consisted of a tower 70 feet high, a concrete mixer of one-yard capacity, steam hoisting engine, boiler, and accompanying equipment. The failure was caused by the fall of a large bucket from the top of the tower just after mixing had been commenced. This fell with sufficient force to pierce the bottom of the scow, which filled with water, turned turtle, and now lies on its side at the bottom of the river, together with the tower and machinery. The fall of the bucket is said to be due to the snapping of a cable.

Cracks in Concrete Roadways

CONSIDERABLE interest has been aroused by the report of Commissioner of Works Harris, Toronto, on the defects, especially cracks, that have developed in the Toronto-Hamilton highway, the 40-mile concrete roadway nearing construction between Toronto and Hamilton. That defects have appeared in this roadway is regrettable, as, with later developments and further experience in the placing of concrete roads, it has been hoped that engineers were gradually overcoming this objectionable weakness in concrete roads. Some of the discussions, however, almost seem to have lost sight of the fact that it is a very difficult matter to lay down a concrete-faced road without cracks developing later, unless a very great added expenditure in the way of metal reinforcement is incurred. In the United States, where the experience in laying concrete roads extends over a longer period and a much greater mileage than it does in Canada, this weakness of the concrete road is well recognized. For example, a report has just been issued by the Portland, Ore., Chamber of Commerce Paving Committee on the comparative value, cost of installation, and maintenance cost, of various types of country roads, and this report contains the following paragraph regarding the concrete roadway:

"It is particularly susceptible to physical forces. This susceptibility is caused by its tendency to expand and contract, principally to contract; the result is that at an early period of its life it develops cracks. . . . It is generally conceded that the crack in the concrete pavement cannot be entirely eliminated. It can, however, be controlled."

In the fourth report of the Illinois Highway Commission, which covered the years 1910-11-12, the following paragraph appeared:

"Owing to the constant movement of concrete pavement, due to temperature changes, it is impossible to prevent cracks forming. On hot days the pavement tends to lengthen and on cold days to shorten. It is evident that the cracks form when the pavement tends to shorten."

Reference is also made to this subject in a report made in 1913 to the taxpayers of Highland Park, Ill., by Mr. Paul E. Green, Mem. A.S.C.E., regarding the road system as it exists in Wayne County. Mr. Green says:

"The large proportion of failures observed by the writer has caused him to seriously doubt the utility of this product as a wearing surface, in cities especially. While cracking will not be a serious defect as far as concerns the appearance on country roads, the writer has always believed that in city streets the tendency of concrete to crack and spawl is always a serious objection to its use."

And later in his report: "Another proper location for such a road would be in the country, where the value of the property will not be affected by cracking." And again: "Practically all classes of concrete pavements on city streets observed by the writer in the last five years have cracked badly before they are two years old. In most cases they are also badly worn." And, finally, of the Wayne County roads he observes: "Thirty-two per cent. of the individual slabs of the 1909 work, twenty-seven per cent. of the 1910 work, fourteen per cent. of the 1911 work, and twenty-one per cent. of the 1912 work is cracking and showing signs of wear." We might add that the Wayne County roads are considered among the best in the United States.

These quotations are not given as an attempt to cover up any defects that may have developed in this roadway. They are simply offered as indicating the information that was available before the work was begun at all. Therefore, if those who authorized the building of this road are surprised at its condition it would indicate that they acted without sufficient knowledge. It has not yet been shown that the engineers omitted to take every precaution known to the profession.

Major Doane on Leave of Absence

Some days ago we noted in one of our exchanges that City Engineer Doane was leaving the employ of the city of Halifax, and, feeling that the situation called for an explanation, we wrote their city clerk for a verification of the report. The reply is so satisfactory that we take pleasure in reproducing it below. Evidently Doane suits Halifax and Halifax suits Doane. We hope the separation may be brief:

Halifax, N.S., Sept. 15, 1916.

Editor Contract Record:

In reply to your favor of 12th inst., I beg to inform you that you are "in wrong" in imagining that our Doane has severed his connection with the city of Halifax as city engineer. For very many years Mr. Doane belonged to our volunteer militia, being a major in the 63rd Halifax Rifles, and some months ago was appointed quartermaster in the 219th Battalion for service overseas. He has been granted leave of absence from his civic duties during the period of the war, but has by no means severed his connection with the city. No other reason than a war like the present could induce Halifax to part with Doane.

During Mr. Doane's temporary absence his assistant, H. W. Johnston, has been appointed acting city engineer.

Yours truly,
L. Fred Monaghan,
City Clerk.

Protection Dyke at Laprairie

The government plans for improving and completing the protection dyke at Laprairie, P.Q., include the construction of a flat-top reinforced concrete culvert, with a clear span of eight feet and a slab thickness of 12 inches; the extension of the drain pipes of corrugated galvanized iron; alteration of the eastern and part of the western slope of the dyke with stone filling and riprapping from 1 to 4 to 1 to 1; raising and widening the iron bridge over Little River St. James; and completing a macadamized road way on the top of the dyke and on the inclined roadways. It is estimated that, in addition to 18,000 tons of stone on the site of the work, 13,000 tons will be required to complete the job.

The first slate-quarry in Canada was opened at Cleveland, Richmond County, N.S., as far back as 1854, and within the next few years several others were opened on the same belt, but small success has attended the trade. Only one of the old slate quarries has survived. At New Rockland is the Prince Albert Quarry, which was opened in 1868. The mineral is a dark grey, uniformly colored, mica slate, with good cleavage and a clear ring. The stock splits easily on the grain, which is vertical. The surface is fairly smooth and flat, and whilst there are considerable pyrites contained in some, others are practically free. The slate darkens much on exposure, but its erosion is insignificant.

Progress on Halifax Ocean Terminals

Substantial and Consistent Advancement in Spite of War Conditions—One of the Largest Port Developments in the World and Easily the Most Extensive in America

ONE of the largest port developments in the world and easily the most extensive project of its kind in America is the construction of the new deep-water terminals at Halifax, at present being carried out under the jurisdiction of the Department of Railways and Canals of the Dominion Government. In this work there are planned many radical improvements, comprising an entire revision of the railway and steamship facilities of the city of Halifax, which are destined to make this one of the greatest ocean ports of the continent. The scheme was started in 1913 and has been consistently carried forward, even during the financial difficulties of the past two years, so that at present a most substantial advance has been made. It is estimated that $30,000,000 will be required to bring the work to completion.

The project, as planned, will be very comprehensive, intended to be co-operative with the Dominion's transcontinental railway schemes and to be an inducement for the transatlantic trade centering around not only interior Canada, but also the United States. The development of the port will be an economic factor in the expansion of the Canadian nation and its growth into a world-trading people. In the period of reconstruction after the war Canada's great eastern port will undoubtedly have a very extensive part to play and the work going forward at the present time will ensure a partial completion of the scheme, at any rate, in sufficient time to take its place in this revivifying period.

Excellent Advantages

The location of Halifax is admirably suited to compete with the large Atlantic ports on the United States seaboard. It is situated on a harbor with exceptional natural advantages, affording direct passage for the largest ocean vessels from the sea through a wide bay entrance to deep water berths, amply protected and sheltered, with plenty of space for manoeuvering. This harbor differs from the St. Lawrence ports in being free of ice the entire year, which renders it specially suitable for year-round ocean traffic. It is furthermore the closest port to Europe and only twenty to forty miles out of the accepted paths of transoceanic steamers bound to or from United States ports.

The government-owned Intercolonial and National Transcontinental Railways have their eastern terminus at this point and it is essential that a port should be projected comparable with the trade which this railway and the private lines will foster. It will therefore be a most important link in the growing chain that will embrace and embody a more widely distributed trade development. Halifax will have, in its new harbor, a dominant advantage in intercepting the European trade, both to and from the Dominion. This trade has been developing and expanding, but a great deal has been regulated by the past superior facilities of United States railways, which have directed a very material part over its transportation systems. It was, therefore, only a part of an economically important policy that more weight should be attached to the establishment of a greater ocean port on Canadian soil, correlated to the great railway developments, so that this growing trade between our people and the European nations may be controlled entirely through our own jurisdiction and be independent of any dictation from outside channels.

Halifax Railway Facilities

Although Halifax is admirably situated so far as ocean facilities are concerned, its development since the railroads have become an economic factor, has been surpassed by the St. Lawrence ports, due, no doubt, to the less accessible railway connections. Halifax, as located on the Nova Scotia peninsula, requires that all rail connections go north to the narrow neck before reaching the city. This defect has prevented Halifax from monopolizing the eastern trade and has promoted the development of the more accessible river ports. However, the new projects, including railway facilities, perhaps second to none on the continent, will ensure the due growth of this most easterly port and will bring to it the trade that belongs to the city by right of its location at Canada's very gateway.

Fig. 1—Showing present terminus and new ocean terminals at Halifax, N. S.

The present position of the railway terminals in Halifax is far removed from the centre of the city. Since the building of the railroad and its location in its present situation fifty years ago the city has grown southward along the bay on which it stands, with the result that the terminal is a considerable distance from the business portion of the city. The ocean terminals are close to the station.

For a long time it has been realized that the rail and ship facilities were inadequate and in an effort to improve conditions, the government undertook in 1910 to reconstruct the existing wharfage by building the large reinforced concrete pier No. 2, which has just recently been completed.

Realizing that this reconstruction would be merely a makeshift and simply tide over an uncertain period,

steps were taken to adopt such measures as would fully meet the requirements. After careful and extended investigation four possible designs were evolved, which would furnish every modern facility, convenience and accommodation. The plans which were pro-

The plan makes ultimate provision for 27 large vessels with deep water berths of 45 ft. depths at low tide. Ample freight and passenger handling equipment will be installed and very extensive railway connections are planned, including a new entrance to the city, which

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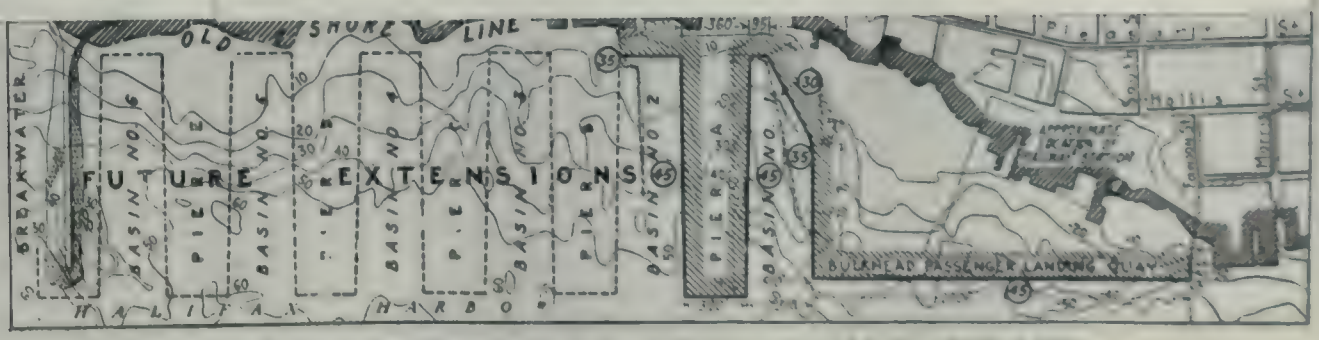


Fig. 2 - Halifax Ocean Terminals showing layout of quay and piers and location of railway station

Fig. 3—East end and south side of pier No. 2 at existing site, just completed—Deep water terminals, Halifax, N. S.

Fig. 4—Interior of new pier and shed No. 2 of the I. C. Ry. deep water terminals at Halifax, N. S.

proposed scheme should be prepared which would provide accommodation as follows:

1. As soon as possible new accommodation for nine steamships.

2. In three or four years, with the advent of new railways, further accommodation for nine steamships.

3. In three or four years more, after the opening of the Quebec Bridge, further accommodation for nine steamships.

4. Possible extensions on same lines in the future.

5. All accommodation to be permanent, first class, and to be suitable for modern steamships of the very largest type.

6. All accommodation to be designed with due allowance made for probable increase in dimensions of vessels.

7. The railway terminals to be improved and increased in the same proportion.

Four Schemes Proposed.

After a very careful reconnaissance, with the aid of the plans and information available, including Bedford Basin, the Halifax Peninsula, and the Dartmouth shore, it was found that sufficient data was not available, and complete topographical and marine surveys had to be immediately organized for.

With full information available, four alternative proposals were carefully considered. Each of these proposals provided for a scheme which would give ultimate accommodation for 20 to 30 full-sized ocean steamships. Scheme "D"—George's Island extension—was adopted.

Following the growth of Halifax, it would appear that harbor development ought to have extended southward as the size of ships increased and the protection required lessened. For this reason it now appears strange that when the railway was first projected to Halifax it was not located to the westward, around the city, to a port terminal conveniently situated relative to the centre of the city. The present plan provides a railway entrance from the west and south.

The physical features of the shore at this location and the depth of water are the best in the whole harbor, and are well suited for harbor construction. The approaches from the city are very much superior to possible approaches from any other location on the peninsula. The scheme provides for a total accommodation of 27 steamship berths. The advantages that are attached to the new scheme are:

1. The union passenger station and ocean steamship terminals are located very close and convenient to the centre of the city.

2. The passenger landing quay is of the bulkhead type, to facilitate the docking and departure of ships, and is located on a part of the water-front where pier construction would not be permissible on account of George's Island, which, however, protects the site from north and northeast winds, and leaves a deep-water channel of at least 800 feet in width.

3. The utilization of a part of the city water-front hitherto but little developed and largely unoccupied.

4. For shipping, a ship making Halifax a port of call may take aboard the quarantine officials and examination may be completed by the time the steamship is turned and ready to dock.

5. For railway terminals, the location, the contour of the site, and the access to the steamship terminals are excellent.

6. Ample accommodation will be provided for vessels making Halifax a port of call, for vessels making it their home port, and for any proposed fast line services.

7. If at any future time it is required, further extensions may be made southward or northward on symmetrical lines.

8. As a whole, the scheme was designed on broad lines, in the interest not only of the city but for the improvement of the trade and commerce of the whole Dominion. It may also be stated that at no part in the world is there a record of any equal development at anything like an equal expenditure.

9. The cost per ocean steamship berth available, including everything required for harbor facilities, will be comparatively low. The estimated cost per standard steamship berth, including land, two-storey quays, sheds, and equipment, is $860,000.

Disadvantages.

The only disadvantage which has up to the present time been established is that the new railway passes through a residential district of which the Halifax citizens are very proud, and its cost will be high, due to the preservation of the city's amenities.

Improved Railway Facilities.

The new railway approach to the ocean terminals commences on the Intercolonial Railway near Rockingham, at a distance of about five miles from the existing deep-water terminals, and about six miles from the proposed new ocean terminals. Between Rockingham and Fairview there has been constructed a new freight terminal yard, by reclaiming a large and comparatively shallow area from Bedford Basin. There will be no grade crossings, the railway being carried under the Southwestern Railway, and in all cases either under or over roads and streets by means of bridges. These bridges have been designed to harmonize as far as possible with their surroundings.

The new union station is to be situated near the corner of Pleasant and South Streets. It will be a large, handsome, and substantial structure provided with all modern conveniences and facilities for passengers and for the handling of baggage, mails, express, etc.

The General Scheme.

The general scheme provided for an outer breakwater, a system of double-berth piers, and a large bulkhead landing quay. The whole scheme will accommodate 27 large-sized ocean steamships, most of the berths to have a depth of 45 ft. at low tide. The landing quay and the railway terminal and station have been designed to provide a concentrated unit for quick despatch. A system of piers and wharves, with railway approach, was designed, so that excavation and filling would result in an even balance, including railway cutting and large classification yards.

The piers have been designed tapering towards their outer ends. The reason for this is to reduce the amount of dredging and walls at the heads of the basins, the amount of walls and filling at the pier heads, and to give the greatest widths of approach from both sea and land, where most required, namely, at the outer ends of the basins and inner ends of the piers respectively.

It was decided that the use of timber in modern construction work was not permissible, in view of the uncertainty and power to resist indefinitely decay and attack from sea worms and insects, danger from fire, liability to damage, and high cost of maintenance, as well as having regard to the best modern practice.

Concrete Construction Employed.

Concrete in its various applications was next studied. Unlike timber, concrete is not subjected to attacks of the teredo and limnoria and their allies.

There are no instances on record of damage done to concrete structures by sea worms. After an exhaustive study of the chemical action of sea water upon concrete it was decided that concrete, if properly constructed, is perfectly safe in these waters, when not exposed to the combined action of sea water and frost within range of or above tidal levels. The whole scheme was, therefore, designed so that all concrete would be moulded in air and fully matured before being exposed to salt water below tide level. Above tide level all concrete work will be protected by a granite wall.

Quay Wall Design.

The quay wall designs for large, modern steamships requiring a vertical wall of some 60 feet in height, capable of carrying a permanent structure with heavy loads and built on rock foundations, called for very careful consideration. A new departure in design was proposed by the writer and very carefully worked out by Mr. James McGregor, superintending engineer, and his staff. Before adopting his design careful consideration was given to the following types: (a) Concrete block work, with mass concrete heart, estimated cost $550 per lineal foot; (b) reinforced concrete caisson floating to position, $540 per lineal foot; (c) solid block wall, $550 per lineal foot; (d) reinforced concrete decking on cylinder pier, $490 per lineal foot; (e) adopted, $490 per lineal foot.

This design was finally evolved and adopted, by which it is hoped to combine the undoubted advantages of reinforced concrete with those of cheaper mass work and eliminate to a great extent the objectionable features of each, and at the same time produce a wall of the gravity type which will be economical and speedy of construction. The wall is designed to be sufficiently wide at high water level to carry the tracks for the block-setting Titan, or travelling crane, and later to support the front rows of the transit shed pedestals and columns. In this design of wall the method is to construct stacks of cellular reinforced concrete shells or hollow blocks, one perfectly above the other, and securely bonded and bedded by means of mass concrete and grout deposited in the front and middle compartments and in the grout holes. The other compartments are to be filled with rock or other provided filling in order to give the wall sufficient weight. All the bottom shells and half of the height of the next shells above are to be completely filled with concrete to form a solid, full-width foundation and ballast floor. Each stack of shells or section of the wall is to be 22 feet long, and is to be keyed to the adjoining sections by means of vertical guide posts. The object of these posts, which are constructed of reinforced concrete, and of varying sizes so as to maintain a true distance to centres of stacks, is to prevent all lateral movements in the event of settling taking place, to facilitate the setting of the shells under water, and to prevent the escape of the filling in and behind the walls.

The spaces between the stacks of shells are to be filled with rubble or other filling, thus forming an expansion joint and a means whereby each stack of shells can settle independently without affecting the adjoining portions of the wall. This type of wall lends itself to speedy and economical construction.

Granite Facing.

The reinforced concrete shells, whose outer faces come in contact with the sea water, are to be build up to one foot below extreme low water level, and the portion of the quay above this level is to be constructed with smaller blocks up to high water level with cut granite masonry and finished with a cut granite coping three feet wide. The reinforced concrete and mass concrete, therefore, will not be exposed to the action of frost between high water and low water.

Mooring hooks or bollards, each designed to fit into and to correspond with the granite coping, and to safely withstand a pull of 75 tons, are to be placed along the face of quays at intervals of 88 feet. In places where it is found necessary this spacing is to be reduced to 66 feet. In order to balance the pull on the mooring hooks the walls at these points are to be anchored back to concrete blocks by means of 2¾ in. diameter steel anchor ties. Granite boat stairs and landings are to be provided at the pier heads, the heads of basins, and at the ends of the passenger landing quay. Iron ladders are also to be placed in suitable recesses at frequent intervals along the faces of tre walls. The contract cost of the adopted design, including mooring hooks, ladders, stairs, fenders, etc., and excluding only dredging and filling, will be, say, $490 per lineal foot.

Progress of the Work.

The contract for the railway approach was let in 1913. It is now practically completed. The first unit track contract was let in January, 1914. The breakwater at the extreme south end of the "terminal site" is completed, and has amply justified both its location and style of construction.

During the year excellent progress has been made with the construction of the quay walls and with the dredging of the rock and other materials. At the end of July, 1916, over 2,000 lineal feet of quay walls have been constructed up to the top of the blockwork; 790 feet on the north quay of basin No. 1, 837 feet on the north quay of pier "A," 154 feet on the bulkhead passenger landing quay, and 220 feet on the south quay of pier "A."

About 500 lineal feet of granite face-work have been set up to the coping stone. Over 500 lineal feet of foundations are prepared on solid rock, ready for the blockwork, and about 1,000 lineal feet of rubble mound foundations are in place and in the course of settling. The dredging in basins Nos. 1 and 2 and along the passenger landing quay is now about 80 per cent. completed. The smoothness, facility, and speed with which the work of dredging, block-making, and setting have been carried out during the past year have more than realized the expectations of the designers.

Manufacture of Concrete Blocks.

The cellular reinforced concrete blocks, which are made in a well laid-out and equipped block yard, are being made at the rate of from 10 to 13 per day, containing from 300 to 350 cubic yards of concrete and from 30 to 39 tons of reinforcing steel. Each block contains about 30 cubic yards of concrete and weighs about 63 tons, the side and partitions walls being 8 inches thick.

The blocks are lifted from their moulding platforms after maturing 28 days, and placed on flat cars by a 150-ton standard gauge railway wrecking crane, enough blocks (13) being loaded on cars at a time to complete one section of quay wall 22 feet long. The crane then travels out to the end of the wall, and the blocks on the cars are run out to it. They are then lifted and lowered into place, being guided into position by the reinforced concrete guide and key posts used between adjoining stacks of blocks. The single crane in operation sets usually one stack of blocks, or 22 lineal feet of wall, a day, but 66 lineal feet of wall

Fig. 5—Showing plan of initial work on new ocean terminals, Halifax. View from tower of mixing plant looking northeast. The lines placed on this photograph show the outside lines of the work as it will be when finished. Dimensions are as follows:—Bulkhead passenger landing quay: north wall, 335.4 feet; east wall, 2,006.0 feet; south wall, 1,208.1 feet. Pier "A": north wall, 1,250 feet; south wall, 1,2[illegible] feet; east wall, [illegible]20 feet. Basin No. 1: width at head, 95 feet; width at east end, 350 feet; narrows at a point 707.7 feet in from the cope line of the B.P.L.Q.

have been built in two days under favorable conditions.

The principle of using as large blocks as possible for quay wall construction, provided that the weight is kept within reasonable limits for economical and, if possible, standard lifting equipment, has been fully justified, as it would be impossible to place small blocks into the wall at a faster rate and with greater accuracy. The cellular construction of the blocks has, in addition to admitting the construction of a very large block for less than one-third the weight of any equal over-all dimensioned solid block, effected an enormous saving of both time and money in foundation work.

The Foundations.

Instead of having to level off and screen the whole of the foundation for the bottom block, concrete stools about 6 feet square are built at the corners of the junc-

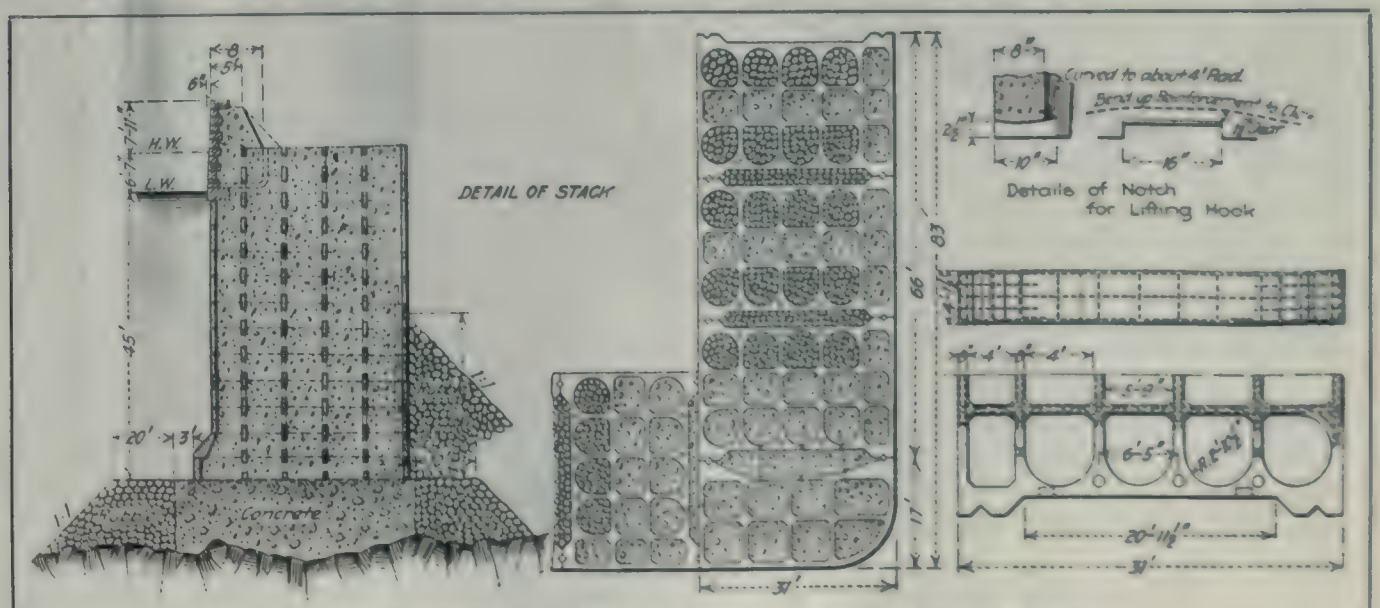


Fig. 6—Details of the concrete block quay wall. 60-ton concrete blocks stacked up to form a 60-foot wall.

Fig. 8—Steel shell forms ready for pouring.

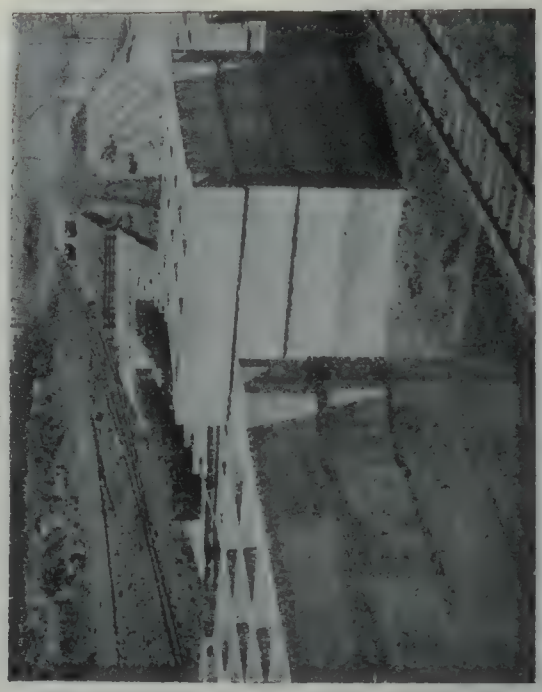


Fig. 9—Hollow concrete quay blocks in storage at Halifax, N. S.

Fig. 7—150 ton locomotive crane; capacity 70½ tons at 33 foot radius; length of boom, 45 ft. 6 in. Crane is seen holding a reinforced concrete shell (S3) weighing 58·3 tons. Dimensions of shell 34 ft. 0 in. x 21 ft. 10 in. x 3 ft. 4 in. The "Strong Back" weighs about 7 tons. Distance from crane hook to bottom of shell is approximately 17 ft. This crane is used for handling reinforced concrete shells in the pouring and storage yards.

tion of each stack of shells. These stools support the stack of blocks, while the remainder of the bottom is left rough and serrated, the mud and debris only being removed by dredges and water jet or by hand in a diving bell or by helmet divers. By this means 22 lineal feet of foundations can be prepared in the diving bell per day, and on a mass concrete foundation two helmet divers have prepared 44 lineal feet of foundation per day.

No doubt if rock foundations were prepared very carefully by the dredges helmet divers could be used to the same advantage on rock as on concrete. It is questionable whether any records can be found where the foundations and superstructure of quay walls built in tidal waters have been constructed with the speed and facility made possible and attained at Halifax by reason of the special design and type of the blocks.

An important erection feature which materially assists the progress of the work is that the block-setting crane is run out over the blocks before the concrete and earth filling is put in them, and while the whole of each stack is simply supported on the 6-feet square pedestals or stools at each corner.

The granite face-work, which is obtained from a government-owned quarry within three miles of the work, will prevent any abrasion of the face and any frost action between tides.

Designs and Methods Amply Justified.

It may be safely recorded that, as far as the work at present shows, all the features of the design are justified, and actual work has shown that the style of construction is better suited to the site of the terminals and conditions at Halifax than was ever anticipated.

The contractors for the railway and later contractors for the docks were fortunately reliable firms, having ample capital and experience. The contractors for the docks recognized the unique features and problems from the start. They carefully laid out their work and provided construction plant which is attracting the attention of port builders the world over. Not one essential modification has been required in the designs or specifications, and the work is now sufficiently advanced so that three berths for the largest type of modern ocean steamship will be available in November, 1916, with railway terminals second to none on the continent.

Personnel.

The authorities in charge of the railway development of Halifax harbor are: The Hon. F. Cochrane, Minister of the Department of Railways and Canals of Canada; F. P. Gutelius, manager of the Canadian Government railways; the writer, and C. B. Brown, chief engineer of the Canadian Government Railways, as consulting engineers on the dock and railroad works respectively; James McGregor, as superintending engineer at Halifax in direct charge of design and construction. Foley Brothers, Welsh, Stewart & Fauquier are the contractors for the docks; the Cook Construction Company, Limited, and Wheaton Brothers are building the railroad connection. The architects for the passenger station and immigration buildings are Ross & Macdonald, Montreal.

Special Methods of Construction

IN the construction of the Halifax terminals special schemes and methods have been developed which have been marked with exceptional success from the first. The designs adopted have been amply justified, and the engineers express themselves as being perfectly satisfied with the progress that has been made. They feel that the style of construction has been better than anticipated. Port builders everywhere have been attracted by the construction plant and equipment, and the contractors have carefully planned their work and evolved processes comparable with the magnitude of the undertaking.

Concrete walls of novel construction are being used in the construction of the landing quays and piers. The special design was selected after careful investigation, and with due regard to the situation. The concrete cells are illustrated in a number of the accompanying illustrations, which show their construction and methods of manufacture and setting.

Quay-Wall and Pier Construction.

The quay-wall method of construction consists in placing on a prepared bottom, in 30 to 60 feet of water, stacks of hollow reinforced concrete blocks, fitting one on top of the other to form the required height, and joined together laterally to form the continuous wall. After setting these blocks, their cells, which line up vertically, are completely filled with concrete for the first five feet, and above that each stack has its face cells and the middle line of transverse cells filled with concrete, the remainder of the other cells being filled with stone rip-rap and sand, so that in effect the completed wall will be a retaining wall, with a concrete base and a concrete face, strengthened with solid counterforts. Topping the wall above low water will be a granite-faced wall in the intertidal space, and up to and including the coping, as a protection against the frost and sea-water action, which might damage the concrete. The shed and warehouse structure will have their forward columns supported directly on the wall and their rear columns on pedestals footing on concrete-pile clusters driven through the fill, which will be placed after the wall is completed.

The advantages of this method are that all the concrete is mixed with fresh water moulded in air, and allowed thoroughly to mature before coming in contact with sea water, and placed so that it will not be subject to frost action. The mass concrete that is deposited under water is placed under conditions as nearly ideal as possible. The design of the walls obviates the necessity of using expensive temporary staging of floating cranes. Expensive foundations for the front row of the shed column are unnecessary. Settlement, expansion, and contraction are provided for by means of the short sections and the leeway afforded by the reinforced concrete guides.

While cellular concrete blocks for subaqueous wall construction are not new, in no other work have they been developed to such magnitude as at Halifax, nor has the method of placing and filling them ever been used before.. The method in which the blocks are being laid can be outlined. The process of laying is also sketched in Fig. 10.

Placing the Concrete Blocks in Wall.

The details of a typical block are given in Fig. 9. As shown in the general elevation, this block is only typical of those in the main part of the shaft, there

being special shapes and sizes for the base blocks and for the top blocks. The block shown, however, is sufficiently typical for the purposes of description. It is 31 feet wide, the width of the completed wall; 4 ft. high and 22 ft. long, and weighs 60 tons. It is reinforced not only against its loads as a part of the wall, but against handling stresses. The walls are solid except for the triangular openings shown, provided so as to insure a good bond with the fluid concrete placed in the cells, and also vertical circular openings for grouting, as afterward described. On each side are provided triangular vertical openings, which serve as grooves to engage the square guide posts used in setting the blocks. These posts are in appearance the same as reinforced concrete piles, and are cast in a similar manner. Great care is taken in getting plane surfaces and truly right-angled edges in the blocks, for upon these features depends the verticality of the finished wall.

The surface of the bottom, upon which the lowest block is laid, is prepared by dredging, or where already low, by filling up to the required grade with mass concrete or a rubble mound. The final levelling is made in the chamber of a diving bell. Inside of this bell the subsurface is cleaned up, and, where necessary, at the back or front brought to proper elevation by filling holes or depressions with concrete, and then low concrete pedestals, each about 5 x 6 ft. footing on solid

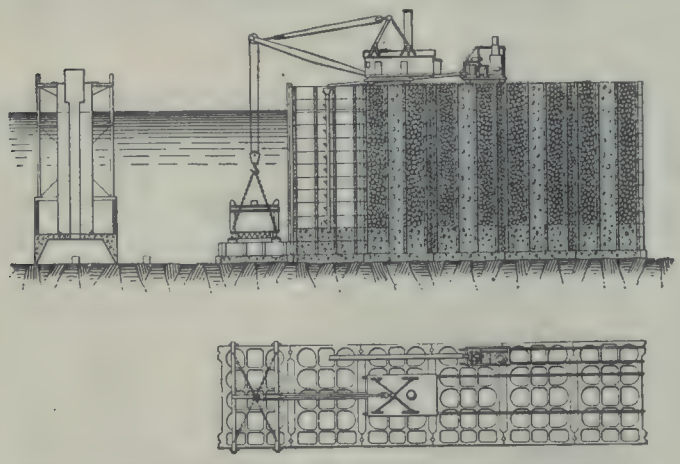


Fig. 10—Method of laying blocks in the quay wall—Halifax Terminals.

rock, or concrete or rubble fill, are laid, with tops finished to true grade about 3 inches above the surrounding bottom. These pedestals are located at back and front at the junctions of stocks of blocks. The first block is then picked up with special tongs slung from a travelling crane, the jaws of the tongs fitting into specially prepared openings in the bottom of the block. With the crane running on a standard gauge track and standing with outriggers set on an already completed stack (see Fig. 10), the block is lowered overboard, effort being made to keep it lightly engaged against the vertical guide posts which have been plumbed and fastened into the corresponding grooves in the last stack already set. After the block is lowered to bearing on the pedestal, the succeeding blocks of the stack are placed until the stack is complete. The sealing concrete for the two bottom risers is then placed by bottom-dump buckets from a floating concrete mixer or delivered from the moulding yard concrete mixer by flat cars running on the standard gauge track behind the crane, and then the filling of the proper cells with concrete to the top of the stack is completed. After this filling is finished, grout is forced into the vertical 10-in. holes, which, matching up, form a continuous well through the stack. It is expected that this grouting will fill any voids left where the bearing of the blocks is not perfect or the concrete filling has left holes. Finally, the remaining cells are filled with rubble gravel and sand.

Blocks Placed With Entire Success.

The placing of the blocks has from the first been attended with the greatest success. The guide and key posts which are carefully plumbed for each stack automatically bring the blocks into true position without the assistance of a diver, whose services are required only for inspection and to see that all is clean and clear for the bottom blocks and mass concrete of each stack. No difficulty is found in keeping the stacks vertical or in securing good alignment. The tendency to "creep" longitudinally or to get out of line is corrected by using different combinations of the three standard sizes of posts provided. The variation in levels between the highest and lowest corners of the top blocks of the stacks as set does not average more than one-half inch. Blocks have been set with a 150-ton standard gauge steam locomotive wrecking crane, which travels out on ordinary railway track laid on stringers resting on the stacks of empty blocks and extended by stack lengths of 22 feet as the block setting proceeds. The same crane is used for lifting the blocks from the moulding platforms to standard flat cars, on which the blocks are transported out to the wall head. As many as two stacks each of nine blocks have been set in one working day, and an average per day of one stack of blocks loaded from the yard and set in the wall is easily maintained.

The landing quay and piers were located to fit as closely as possible to the natural shore line, so that excavating below water for the required depths would be at a minimum. However, it is necessary to dredge about 250,000 cubic yards of the rock bottom to attain the desired low-water depths (maximum 45 feet), and this spoil is used mainly in filling in behind the walls. This excavation for the most part is in fairly hard rock, which requires blasting before dredging; but in some low areas the rock lies at a depth of from 50 to 90 feet, and it is necessary to dredge out the overlying mud. In these sections a granite rubble mound is deposited to form a foundation for the quay-wall blocks.

Breakwater.

The breakwater at the southern end of the harbor site consists of a rock-fill or embankment formed of rock excavated with steam shovels from the railway cuttings west of Young Avenue, and has been dumped from 16 cubic yards standard gauge air side dump cars.

A temporary timber trestle about 300 feet in length was first used for dumping from the short end, and beyond that the dumping has been done from a steel span 40 feet long, supported at its inner end on the end of the rock embankment and at the outer end on a timber scow 34 feet wide by 90 feet long by 8 feet deep, subdivided by bulkheads and provided with steam hoisting engine and centrifugal pump for moving the scow and span and for adjusting the scow by water ballasting to suit all stages of the tide. This scow also carries tail track for three of the 16 cubic yards standard gauge dump cars.

The riprapping of both slopes of the core to form the sides of the breakwater with large blocks of rock weighing five to eight tons each has been advanced immediately behind the core filling, a steam locomotive crane being used for loading and unloading and placing the larger blocks of rock. This simple method of constructing the breakwater has proved very efficient.

(Continued on page 946)

The Economic Value of Port Facilities

PORT developments are second only in importance to the construction of railroads in the upbuilding of a nation like Canada. A country with any extent of seaboard and with any deep desire to take a place among the industrial and commercial nations of the world must needs organize its port facilities so as to provide for the trade that comes to or from its shores, something that will stimulate and promote commercial development, and that will ensure a natural and orderly growth in international trade relationships. It is a matter of pride on the part of Canadians that our governments have realized the extensive part our great ports will have to play and the importance they will assume as this country grows and the value of its productions and the amount of its needs increases. On both oceans and on the inland lakes great harbor schemes are in progress or have been planned which are destined to bring to Canada a greater amount of maritime prestige.

There are certain features of port organization and certain principles that have to be followed if the greatest gain is to be obtained and if the people at large are to derive the maximum benefit. In Canada we are under certain advantages, in that the Dominion Government directly controls the harbors and ports and formulates their improvement. In the United States, on the other hand, federal aid is not, as a rule, extended to such developments, and for this reason many ports have become controlled by private interests and corporations.

Some of the basic principles governing port organization necessary to promote the highest economic advantages were outlined in a paper on "Terminal and Rail Facilities," read by Robert Bridges, president of the Seattle Port Commission, at the fifth annual meeting of the American Association of Port Authorities, held at Montreal on September 13-15. This paper develops the factors that should govern the organization of rail and water terminals, pointing out the difficulties met and overcome in the case of the Port of Seattle. Mr. Brigdes points out many details of general importance which are worthy of special note, and from which we quote rather freely in the following paragraphs:

The Basic Principle.

The basic principle of port organization is that a port must be developed as a unit, under public dictation of the terms on which private carriers, shippers, and consignees shall be served. The port, being once conceived as an organic whole, publicly administered for the benefit of all, there can be no thought of remaining in, or returning to, the chaos of jarring private rivalry and mutual obstruction from which most ports suffer, or of final dependence on the makeshift policy of separate sub-ports constructed by great private corporations, no matter how perfect each may be in itself or how welcome they may be as co-operators in a general system.

In analyzing an efficient port five essentials are enumerated:

(a) Comprehensive port development plans.

(b) Provision for publicly controlled port terminals, the main features of which shall be a marginal railroad, making accessible all parts of the foreshore to all shippers, and over which traffic should move, as freely as marine traffic moves in front of the docks.

(c) Supervision and publicity of port affairs by the federal government, to supplement the deficiencies of port administration and accounting by cities and provinces.

(d) Provision for financing the ports by publicly acquiring and improving marginal lands and industrial sites in the rear of the docks and by having recourse to the recent and more liberal construction placed by the courts on the riparian rights of the public.

(e) Enlargement of public control and ownership through taxation.

Public Ownership of Terminals.

Terminals should be impartial public intermediaries between land carriers and water carriers, and the right to all marginal lands should belong inalienably to the people at large. On the proper control and development of such marginal area great and increasing interior populations depend for many of the necessities and comforts of life. Harbors physically and commercially accessible to the great water carriers now appearing on the seas are few compared with the enormous North American coast line. The marginal area, whether called foreshore or sea wall lots, tide flats, or levee district, thus becomes susceptible of natural monopoly by railroads and other great corporations or of being held out of use, either for speculative rise in values or to deter competition of rival railroads or steamship systems. The principles of common law, both Anglo-Saxon and Continental, retain in the public the right of access to such highways by people of the interior. The marginal area referred to is the natural area for public quays or piers for docking ships and the rapid and economical handling of transit freight. It is the natural area for chains of public storage warehouses, elevators, cold storage plants, and the like. Lastly, it is the natural area for a co-ordinating marginal railroad tying together in an efficient manner the waterfront units of the public harbor.

The port that lacks in these three elements falls short of a proper standard of efficiency, economy, and despatch.

The community, whether the control is national, state, or local, that allows any of these three elements of port service to be farmed out into private or corporate hands for private profit, is derelict in its duty to the state and nation whose gateway it holds in trust. In Canada the title to the foreshore is unmistakably in the crown, and there is a clear understanding with regard to the waterfront situation.

A Priceless Possession.

The waterfront of a great seaport is a priceless possession in the hands of those who control it. Such possession enables its proprietors to levy tribute upon every pound and item of outgoing and incoming commerce moving to and from every corner of the world. Hence the aggressive and ever-insistent effort on the part of transportation companies and other profit-seeking corporations and interests to secure control of this valuable property. The history of all United States ports—save San Francisco and New Orleans—has been in this regard practically the same. Private corporations, and particularly transportation corporations, have acquired practically all the available commercial waterfront of America.

A port whose waterfront is preempted by private railroad terminals is necessarily restricted to the service of the railroads owning the same. All other rail-

roads in the future, no matter how anxious they may be to enter such port and no matter how advantageous the entrance of such railroads might be to the community, are denied the necessary facilities. Furthermore, such port under such conditions is destined inevitably to become a mere convenience to such franchise owners, to be used by them as a trans-shipping point merely, without regard to the interests of the donors of the franchises, but with regard only to the profit of the corporations owning the same.

I have said that the waterfront of a great seaport is a priceless possession in the hands of its proprietors. There are two distinct kinds of ownership and utilization to which this possession is subject. The port facilities may be owned and operated by private corporations, as heretofore detailed, or the ownership and operation of the same may rest in the hands of the municipality or the people. If private interests are the proprietors, then such facilities are exceedingly valuable assets for the production of revenues and the generation of power for such private interests. If these facilities are owned by the people and operated in their behalf, then the resultant benefits flow toward the municipality as a whole and toward the individual citizens who constitute the same.

An Open Port Necessary.

From what has been said before, it is obvious that the fundamental benefit of public ownership, control, and operation of port facilities is that thereby the port is kept open—that is, no special interest or combination of interests is permitted to monopolize for selfish profit the tollgate that opens out upon the limitless commerce of the seas, on the one hand, and upon the great highways of inland trade on the other. The secondary or sequent benefits that follow this fundamental fact are that all transportation agencies, not only in present but in prospective operation, are invited to conduct their business through such open port upon the basis of equal facilities, minimum charges, and equitable terms; that such invitation and treatment will not only increase the volume of traffic through such ports, but will place such transportation agencies in the relation of active competition with each other.

It is a fact that trade follows the line of least resistance, or, in other words, will gravitate towards that environment which is most favorable to expeditious and inexpensive movement. Active competition between transportation companies is a consideration of primary importance. Private ownership of terminal facilities will close the port and strangle competition; public or neutral ownership will produce the directly contrary result. Assembling cargoes for shipment, warehousing the same when necessary, docking the ships, transferring goods from railroad to railroad, from railroads to ships, from ships to railroads, and from industry or factory to trunk lines and wharves, are all units of movements which entail expense. The more efficiently and economically these units are coordinated the less will be the charges and the more satisfactory the service per unit or per combination of units. It should, therefore, be the aim of those interested in the development of the port to address themselves earnestly to these considerations.

Guide Posts to Progress.

There are perhaps five guide posts that lead to good port progress:

First.—To lay out a comprehensive scheme of harbor improvement, educate your community, and see the thing through. Expect opposition—"you cannot make an omelet without breaking eggs."

Second.—That modern docks should be constructed and kept publicly owned and operated. Public ownership without public operation is cowardice and betrayal of public trust. Every lease is a surrender of vital public control.

Third.—That a system of public warehouses behind, supporting and physically connected with the waterfront docks is an essential provision of efficient ports, and such warehouses include specialized units such as grain elevators, cold storage plants, and public fueling bunkers and tanks.

Fourth.—That a public switching railroad to tie together all the railroads, steamships, warehouses, and docks is the key to public control of the port. "A public terminal system is impossible without a public marginal railroad system."

Fifth.—That the foreshore legally belongs to the people.

British Port Policy.

Whatever defects may exist in the British system of administration (and they are admittedly numerous), and however grimly the "dead hand" of stupid custom may rest upon and classify men, giving privilege to some and poverty to many in a democratic empire, Americans must nevertheless admit that British port policy is vastly broader and more effective than the theory of "letting George do it" which is the rule in most harbors of the United States. Americans cling to the individualism of the days of the clipper ships, while British port policy, like German port policy, is adapted to the needs of world-wide organizations and steel steamer fleets.

The British policy has resulted in national control of ports; in continuous policy in their planning and improvement; in adequate financial support; and in crown title to the foreshore, enabling docks, elevators, and belt line railways to be built without prohibitive outlay upon ground already owned by the public.

The British policy of national control of ports is exemplified in Canada at Montreal and Vancouver where the harbor boards are appointed by the Dominion Government. The United States Government has no visible interest in her great ports such as New Orleans, San Francisco, Boston, or Seattle.

The British policy recognizes ports as gateways to the interior. National credit is pledged in providing funds for their development. The $25,000,000 supplied Montreal by the people of all Canada was an appropriate national expenditure for a national purpose.

Lastly, the British policy, well illustrated in neighboring Canadian ports, keeps public control of access to the ocean. If private individuals wharf out to deep water or if corporations, like the Canadian Pacific, become squatters on the tidelands, as at Vancouver, the general government—the crown—has only to pay the determined value of the improvement and order them off. The lip of the sea vests in no man.

A Belt Railway the First Requirement.

The first great essential that is required to ensure the absolute success of any port is a publicly owned railway at the waterfront. A public belt railroad or steel highway tapping every trunk railway and serving every steamship, freight boat, or lighter touching the waterfront is the ideal to be attained by every port of this continent. It is the unit of universal service, giving equality of opportunity, articulating and co-ordinating every land and water carrier, however conflicting and diverse may be their competitive interests. Every dock, every storage warehouse, every cold storage

reservoir, every fuel bunker, every waterfront industry, every factory, every wholesale assembling and distributing plant reaching out to marketing avenues, can be served to the highest degree of efficiency, economy, and despatch only by such an impartial public intermediary. A public belt line, giving equal access to all railways and steamships from all parts of the city reached by it, would afford new opportunities for development to outlying sections of the city, taking care of both carload and express package shipments.

In conclusion, Mr. Bridges expresses the hope that the nationalizing of railroads will take place, believing that in such a course there is a remedy for the difficulties that now apply to transportation problems, and more especially those problems that are concerned with the inter-relationships of rail and ship commerce.

Fall of Quebec Bridge Due to Broken Casting

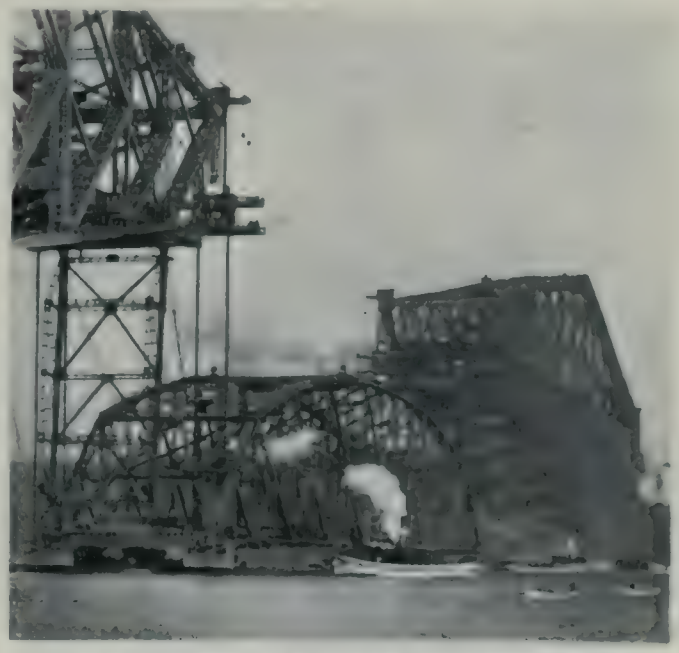
THE following brief description of the actual operations on the Quebec Bridge span, which was raised to a height of 12 feet before the failure of a cast steel bearing on the lower lifting girder at one of the corners, resulting in its fall, may now be accepted as the official explanation of the accident. In spite of a number of more or less hasty criticisms, it does not appear that any faults developed in the design of the bridge or the bridge span. Neither is there any apparent force in the contention that this method of erection can never be successful; there is no information to indicate that the span showed signs of buckling, due to its abnormal length and weight, during the three hours it hung suspended. Whether the minor detail fault which precipitated the whole trouble could have been avoided by a more rigid inspection or more eternal vigilance will possibly also remain a matter of dispute between those who accepted the responsibility of inspection and those who were mere onlookers.

At 6.50 a.m. the span arrived at the bridge site, and the mooring lines were connected up to the cast steel snubbing posts located at each of the four corners of the suspended span. These 1¼-in. steel mooring ropes, eight in number, four at each end of the span, were calculated to take a pull of 75,000 pounds each, and passed through sheaves at the lower corners of the mooring trusses, and from there up to a nine-part ¾-inch wire rope tackle, which led back to the drums of the derrick hoists, situated on the bridge floor at the ends of the cantilever arms. The span was pulled directly under its final position in the bridge by means of these 1¼-in. ropes and the derrick hoists. The hanger lifting chains which were to raise the span were then lowered and connected through the slotted holes at the lower ends to the pins at the top of the short hanger links connecting to the supporting girders under the end corners of the span. This connection was made at 7.40 a.m., when the current was practically at zero—that is, the tide had turned and the current was about to change from a westward to an easterly flow.

The mooring frames were made up of two steel trusses braced together, the bracing being designed to take a transverse pull from each end of the suspended span of 300,000 pounds. They were pin-connected to the cantilever arm floorbeams so that by means of the nine-part ⅞-in. wire rope tackle leading from the lower corners of the trusses to the connection to the floor between panel points CF5 and CF6 of the cantilever arm, and from there to the main hoists situated on the bridge floor, they could be raised so as not to obstruct the channel unnecessarily.

The hanger chains at each corner of the span were made up of four slabs to each chain, each slab being built up of two 30-in. by 1⅛-in. carbon steel plates. The slabs were manufactured and shipped in lengths of about 30 ft. centre to centre of end connecting pins. They were controlled after being suspended from the jacking girders located at the elevation of the bottom chords of the cantilever arms, by means of a two-part tackle connecting to the cantilever arm trusses at panel point CL2.

The hoisting apparatus at each corner of the span is illustrated in the figure herewith. A pair of supporting girders 6 ft. 11½ in. deep and 25 ft. long and braced together by bearing and pin connecting diaphragms and cover plates were placed under each corner of the span. The plate lifting chains were pin connected to these girders and also riveted to the same girders and passed up through a set of upper and lower jacking girders, to which they were altrnately pin connected as the jacks between the upper and lower jacking girders were operated. These jacking girders were



Quebec Bridge showing the suspended span floated into position between the two cantilever arms and connected to the hanger lifting bars. The load is still carried by the scows.

each made up of two plate girders 9 ft. deep and 22 ft. 6 in. long, connected together by cross-bearing diaphragms and cove plates. The upper jacking girders were the movable girders, and slid up and down in the stiff built guides, which were riveted into the lower jacking girders, passed up through the upper jacking girders, and connected to the stiff hangers which led on up to the upper supporting girders. These upper supporting girders were placed on top of the CU0 joints of the cantilever arms, and were of similar construction to the lower supporting girders. The load of the span was transferred to the upper and lower supporting girders by means of cast steel rocker bearings, designed so as to allow the span to sway in any

direction under the influence of external forces from current and wind which might have acted while the span was being hoisted.

The total load carried by the hanger chains while lifting the span was 5,147 tons. The supporting girders, hanger chains, jacks, and jacking girders and all their connections were designed throughout to carry this lifted load plus 20 per cent. impact.

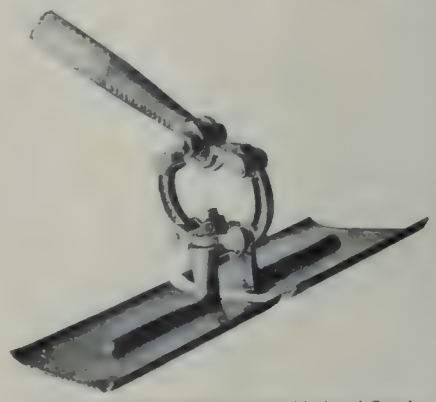
The work of hoisting was done by eight 1,000-ton hydraulic jacks, placed two at each corner of the span. These jacks were operated under a pressure of 4,500 pounds per square inch, the water being supplied to them by a pair of direct-acting double-plunger pumps, operated by compressed air and located on the centre line of the bridge floor at the ends of the cantilever arms. Valves placed in the feed pipe lines in front of the pumps controlled the water supply sent to each corner of the span, and by this means and with the aid of an indicator, which showed any difference in elevation between the two sides of the span, the span was kept approximately level. Another set of valves with a similar indicator attachment was located in front of each set of jacking girders and controlled the water supplied to each separate jack and by means of which the jacking girders were kept horizontal.

The Collapse of the Span.

At 8.30 a.m. the tide had dropped sufficiently to make the pins bear at the ends of the slotted holes in the hanger links, and the links themselves had straightened out. At 9 a.m. the tide had fallen about a foot and a half further, and the first jacking was commenced. Each operation of the jacks lifted the span two feet. During the lifting, or upward stroke, the 12-in. pins engaged the hanger chains through the diaphragms in the upper jacking girders. At the finish of the stroke the pins were entered in the diaphragms of the lower jacking girders to engage the hanger chains. The upper pins were then removed, the jacks and upper girders lowered, the upper pins again entered, the lower pins removed, and the jacks again operated. The first operation of the jacks was completed in 15 minutes; the second and third operations in about 13 minutes each. At the end of the third operation the span had lifted clear of the scows, the scows had drifted away and were taken care of by the waiting tugs, leaving the span supported entirely by the hoisting apparatus on the ends of the cantilever arms. The fourth stroke was completed, after which an intermission of about an hour was allowed, in order that the working men could get their breakfast; and, upon their return, the jacks were again operated. The sixth stroke had been completed, and while the upper jacking girders were in the act of being lowered **the cast steel bearing on the lower lifting girder supporting the span at the southwest corner failed.** The span slipped off the support at this corner, the sway and lateral bracing then collapsed, precipitating the span into the water. As it fell it turned over to the west, and plunged to the bottom of the river, where it lies, a mass of twisted steel, 200 feet below the river surface. As the load of the span was suddenly released from the ends of the cantilever arms these arms whipped back, vibrated and swayed to such an extent that a number of the workmen, engineers, and visiting members of the engineering profession assembled to view the hoisting of the span, were thrown off their feet. These vibrations lasted for some seconds, then gradually subsided, leaving the anchor and cantilever arms in the same condition as they were before they had taken the weight of the span. Check elevations have since been made, and it has been established, after examination, that these arms are apparenly uninjured in any manner, after having been subjected to a more severe test than would have been possible under ordinary service conditions.

A Double-Action Split Float

The accompanying illustration shows a divided or "split float," as it is more commonly called, produced commercially as a result of an increasing demand on the part of concrete road builders. The difficulty which was experienced by road builders in getting the concrete on both sides of the joints in a true plane resulted in home-made split floats of wood, many of which are now in use. The tool shown in the accompanying illustration is of steel, and, while the general trade has not yet entirely accepted the idea of steel for a float where a float finish rather than a trowel finish is wanted, the experience of some users with just such floats has been most satisfactory, and their use is increasing. This float has the double action, which facilitates its manipulation. The tool is made of cold pressed steel, 6 in. wide by 12½ in. long, with a ½-in. opening in the centre so that the joint may be straddled. The bridging over this opening has an upward bend of 1½ in., giving ample room to take care of the surplus of felt strips used in the expansion joints. The tool is built to permit the use of a long handle. It is manufactured by the Abram Cement Tool Company.



A Double action Split Float Made of Steel.

Progress on Halifax Ocean Terminals

(Continued from page 942)

It is interesting to note in connection with the new railroad pier, No. 2, which has just been completed, that huge reinforced concrete piles, 77 ft. long and weighing 46,000 pounds, were employed and in driving them the largest steam hammer ever built was used, which, with its follower and guide, weighed 28,000 pounds. Its ram is 4,000 pounds in weight, and develops 3,916,000 foot-pounds per minute.

Railroad Excavation.

The total excavation in connection with the new railroad entrance to the harbor site involved an excavation of about 1,750,000 cubic yards, and the deepest cut was about 60 ft. It was impossible to balance the cuts and fills, so most of the work was in cut, the spoil being carried north to the freight yard and south to the breakwater and back-fill for the quay and pier wall.

The Canadian Pacific Railway during the fiscal year just ended carried 1,255,561,198 passengers one mile, against 1,164,488,630 last year. The grain carried this year was 276,788,209 bushels.

A Good Roads Association Formed in the Province of Nova Scotia

AT meetings held at the Board of Trade, Halifax, on September 15, the Nova Scotia Good Roads Association was formed. The meetings were very well attended, about 200 delegates from all parts of the province being present. There has been a growing public opinion throughout the province in favor of permanent road building and judicious borrowing and expenditure of money for this purpose. Nova Scotia has about 18,000 miles of road, and has been able to build macadam roads at a comparatively low cost owing to the presence of large quantities of trap rock. Lately attention has been given to the building of bridges and culverts, and it is now considered that the time is favorable to take up the question of roads—to build more and better highways and to inaugurate a policy of a higher standard of maintenance. The formation of the Good Roads Association marks the culmination of these growing efforts, and expresses them in a tangible organization, prepared to foster the movement for better highways.

The meetings were attended by Mr. J. Duchastel, engineer of the city of Outremont, P.Q., and president of the Dominion Good Roads Association, and Mr. G. A. McNamee, secretary of the association, who were specially invited to be present. These gentlemen gave some information as to what is being done elsewhere in the Dominion, especially in Quebec, with the idea that such knowledge can be utilized, having regard, of course, to local conditions. Mr. Duchastel and Mr. McNamee had conferences with Premier Murray and with the Hon. E. H. Armstrong, Minister of Public Works. They also visited the exhibition, where models of various roads were on view.

Progress in Nova Scotia.

There were two sessions. At the first Mr. Armstrong presided, and pointed out that Nova Scotia had made some progress in the development of good roads, although handicapped by the fact that the province had a large number of rivers, small streams, a heavy rainfall, and a short season in which to work, and that the character of the soil militated against good roads. The introduction of the automobile had given a new impetus to the demand for good highways, making it necessary to reconsider the problem of road making and repair. They were all agreed as to the economic necessity of such roads. The motto, "We want good roads and we are willing to pay for them," interested him, in view of the necessary legislation which must be adopted. The cities and towns must pay largely if they meant what they said, that they wanted good roads and were willing to pay for them.

Mr. G. A. McNamee, of Montreal, who was especially invited to attend, suggested that a good roads association be formed, with representatives from societies and boards of trade of the whole province. He outlined what was being done in Quebec, and explained the good roads laws in that province, pointing out that over $15,000,000 had been expended since 1912 on better highways.

Considerable discussion followed, the general idea being favorable to the formation of an association. The improvement of roads would, it was stated, bring in tourist traffic, and thus benefit the province. At present there are 1,500 miles of main highways and only a little over $100 per mile per annum is being set aside, which was, of course, entirely inadequate.

At the evening session it was decided to form the association. Mr. G. F. Pearson, of Halifax, was elected president, with the following other officers: First vice-president, Mayor W. H. Roach, Windsor; second vice-president, Mr. J. S. Whyte, Glace Bay; third vice-president, Mr. W. Churchill, Brooklyn, Yarmouth County; secretary-treasurer, Mr. R. P. Bell, Halifax; together with a number of representativs of various counties. The fee for ordinary members was fixed at $1; sustaining membership, $10, and life membership, $100.

Mr. Pearson stated that a meeting is to be held before the next legislature convenes, at which a definite road policy will be formulated to be placed before the legislature at its next assembly.

Mr. Duchastel, president of the Dominion Good Roads Association, read a paper on the benefits of good roads, drawing particular attention to the economic and social aspects of the question and also discussing the subject of grades.

Benefits Accruing to Good Roads.

Mr. Duchastel said in part: "No community had ever regretted the improvement of its roadways. In Canada there was no form of natural development of greater benefit to the people at large than road improvement. The public road is, of all forms of intercommunications, the only free one, and also the most universally used."

He pointed out the benefits accruing to a well-constructed highway system, these being of both an economic and social order. Advantages were gained by both farmer and city dweller, which were reciprocal, in that benefits gained by one had a favorable influence on the other.

Mr. Duchastel discussed the different ways of improving the roadways, classifying the methods as betterment of the road surface, reduction of grades, and shortening of the road itself. It was stated that the farmers of Canada would save $5,000,000 a year if we had a system of roadways equal to those of Western Europe.

"Motor traffic is bound to make use of good roads, and one of the important benefits derived by the community at large is the wealth distributed by the motor car tourists. Since the local Government of Quebec commenced the improvement of highways there has been a very valuable increase in tourist traffic in the province. It is figured that each tourist will spend at least ten dollars a day."

Mr. W. G. Yorston, assistant road commissioner, described the road system in Nova Scotia. The revenue available for roads in the province was $235,000, which covered repairs to bridges, machinery account, and maintenance of roads. The administration of this money was by road inspectors in each county, submitting to the commission particulars of what work was to be done. Deducting maintenance of bridges and upkeep of machinery, the amount available for roads was $180,000 for 18,000 miles of roads. Counting in the value of statute labor, a total of $22 per mile was available. The amount allotted was far too small for the needs of the province.

There had been borrowing on capital account in

recent years. One loan was $600,000 for permanent culverts, and another was $180,000 for permanent work in each county, the division being about $10,000 to a county.

Revenue from the motor vehicles was rapidly increasing. It was now about $35,000 a year.

Not Sufficient Money.

The amount borrowed already is far too small for the needs of the province. There was need of constant supervisors of highways for the whole season, and not men who made their road work a side line. In nine cases out of ten the men appointed were not road men or men who had any knowledge of road methods.

Mr. Hiram Donkin, road commissioner, said no matter how much money was granted for road building it was useless unless there was a strong organization to see that it was prudently and efficiently spent.

Mr. A. K. Maclean, M.P., believed that the chief problem was one of maintenance. He suggested that there should be a modification of the statute labor law, or that it should be abolished.

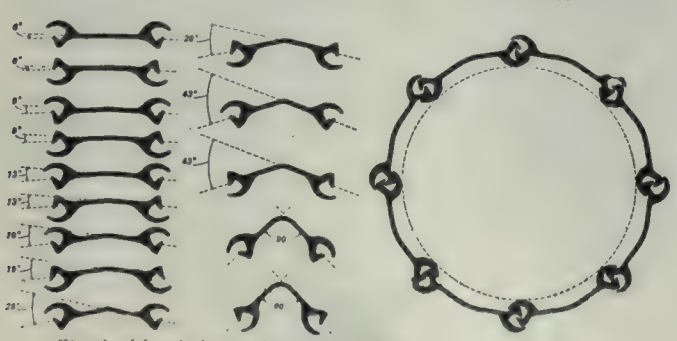
Other speakers included Messrs. W. L. Bishop, road supervisor of Nova Scotia; Mr. J. H. Manning, and Mr. D. McGillivray.

Unique Steel Caisson Construction

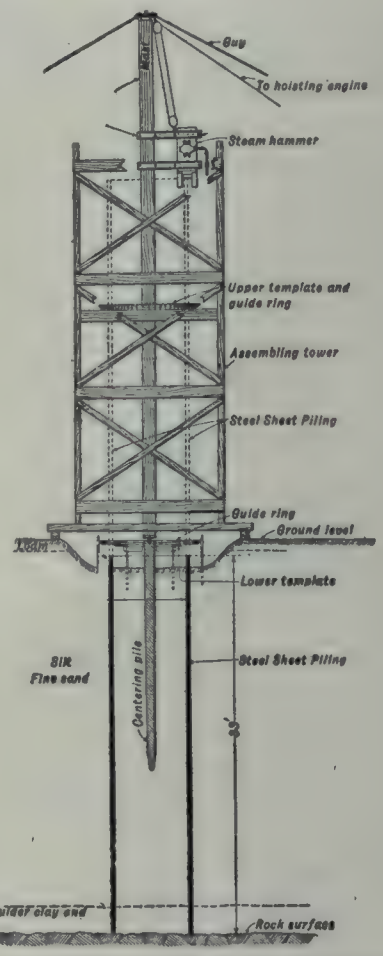
In the Contract Record of June 28 was described a unique scheme for constructing the concrete foundations in connection with the new power house of the Buffalo General Electric Company on the Niagara River. The illustration which we reproduce herewith shows the equipment employed in assembling the sheet steel caissons, and makes more clear the methods that were used.

A centering pile was driven in the exact centre of each caisson location which supported on a pin a 42-ft. mast, guyed in place, but so as to be capable of revolving freely. On this mast was carried the steam hammer, provided with vertical and transverse adjustments, the steam lines being hung over a set of blocks on the top of the mast. A fixed template, circular in shape and of the exact interior diameter of the caisson, was fastened on top of the centering pile, with a second template on the mast 17 ft. above the first one. A falsework tower, with platforms, enabled the workmen to assemble the piling. Each caisson was completely set up as indicated in the dotted lines, the piles being handled by a cableway 70 ft. above the ground. Two piles were always driven at the same time to a depth of 3 ft., the hammer being revolved round and round until all the piles reached bed rock. Excavation was carried on by jetting.

The well-known Lackawanna steel sheet piling, 12 in. x 3/8 in., was employed in lengths of 33 ft. For the larger caissons the angle allowed by the interlocking joints did away with any curving or bending of the piling, but in the caissons of smaller diameter the webs were bent longitudinally to allow the piles to be assembled. The manufacturers are bending straight web piles along standard angles, which enables contractors to form cylinders of any diameter. The accompanying illustration shows the standard bends for sheet pile webs, each stock size being curved right-handed and left-handed, as indicated.



Standard bends for steel sheet piles and bent piles assembled for cylindrical caisson.



Equipment for assembling and driving the sheet pile caissons.

Burlington Steel Booklet

The Burlington Steel Company, Limited, Hamilton, Ont., have issued a very interesting and splendidly illustrated booklet on "Concrete Reinforcement Bars." The earlier pages of this booklet give a quantity of useful information regarding the various forms of reinforcement and methods of manufacture and preparation, with numerous formulae. Several pages are given over to illustrations of buildings in which Burlington reinforcement has been used. Two valuable tables at the end of the booklet give the weights and areas of square and round bars and the weight in pounds of flat steel.

Two million dollars worth of bonds are to be floated immediately by the province of British Columbia to aid the Pacific Great Eastern Railway in completing its line to Prince George. Men have already been sent north to Clinton, B.C., to rush ahead the track from that point, in the expectation of reaching Prince George some time this fall. The bond issue was recently authorized by the provincial legislature.

Practical Methods of Measuring Flowing Water

Continued from last issue

Another kind of velocity determination of special interest is the color method as applied to flow in pipes, closed conduits, and open channels of uniform cross section whose depth is at least one-third the width. The process consists, briefly, in discharging a small quantity of coloring matter into the conduit and noting the length of time required for it to appear at some point further down in the line. In determining the flow in sewers by this method, the coloring can be added at a manhole, preferably near the discharge end, and the elapsed time observed until it appears at the outlet. The distance traveled, divided by the time, gives at once the mean velocity of flow, provided only that the flow is turbulent. As to whether this condition exists or not can be determined in two ways. First, by the use of empirical formulae, such as that developed by Osborne Reynolds, in which

$$V = \frac{.2458}{D\,(1 + .0337\,T + .000221\,T^2)}$$

where D is the diameter of pipe in inches and T is the temperature of the water in degrees Centigrade. If the velocity is as great or greater than that determined by the formula, the flow is turbulent. Another and perhaps better way for determining the condition of flow as regards turbulence is by actual observation.

If, for instance, the flow is turbulent, then water which is at one instant in the centre of the pipe, traveling at the maximum velocity, will, an instant later, be whirled out near the side of the pipe and traveling at a lower velocity, and that water which was near the side of the pipe will now be near the centre, so that the average velocity of the different particles will be nearly constant, and it will make practically no difference where they may happen to be when the coloring is added—they will, in any event, reach a point down stream at very nearly the same time. In other words, if the flow is turbulent, the length of the color streak as it appears at the outlet will be surprisingly short, usually not more than 1 per cent. of the distance traveled. If the velocity should be decreased, then as the flow approaches stream line motion the color streak at the outlet will lengthen greatly and the method will not be applicable.

In 68 experiments conducted by Parker on a 12-in. pipe, 2,074 ft. long, the greatest length of color streak observed was 14 ft. The coloring first appeared after 598.2 seconds, nearly 10 minutes, and completely disappeared 4 seconds later. Hence, the mean velocity was less than 3.467 ft. per second, and greater than 3.444 ft. per second, the mean value 3.456 ft. per second being perhaps more nearly correct than could have been obtained by any other means. This method has the advantage of being easily applied, is inexpensive, and is capable of giving very good results.

In measuring sewage or water not used for household purposes, a fluorescent dye serves well for coloring. By placing a white surface below the water at the outlet, the eye is aided materially in making the observation. In case the water is to be used for household purposes bran may be used, this being later strained off by the aid of cheesecloth; or permanganate of potash may be used, this being decolorized by the addition of a little ferrous sulphate.

Measurements falling under the second class of mean velocity-area methods comprise the most usual methods employed in ordinary measurement of river discharge. The instruments used, as previously stated, are: Surface floats, rod floats, current meters, and Pitot tubes. A gauging by this method is preferably made from a bridge, but if no bridge is available, and the stream is too deep for wading, then either a boat must be used or a cable suspended across the stream.

The first step after the site for the gauging has been selected is to divide the total width of stream into a number of sections, ranging in length usually from 5 to 10 ft., the limits of these sections being marked either on the bridge or on a wire or rope stretched across the river. The depth at each of these limiting points is determined by a rod or sounding weight, or, better still, the elevations of the bed of stream may be determined by aid of a level and level rod. The next step is to determine the mean velocity for each of these sections.

When this is accomplished by the aid of surface floats, a partially filled bottle with only the neck projecting above the surface may be used to advantage. The surface velocity is determined by noting the time required for the bottle to travel a certain distance, usually 100 ft. Eighty-five to ninety per cent. of this surface velocity, depending largely upon the depth of steam and wind conditions, gives approximately the mean velocity for the total depth at that point. After thus determining the mean velocity at the ends of the section, the average of the two is computed, which, multiplied by the area, gives the discharge for that section. The sum of these discharges for all the sections gives the total discharge of the stream. This method gives only approximate results, but is sometimes useful in the determination of flood discharge or in reconnaissance work.

Rod floats can, under proper conditions, be depended upon to give better results, and may, sometimes, be used to advantage in streams where the cross section is uniform for a distance of, say, 100 ft. These floats are designed to give directly the mean velocity in the vertical. Hence, they should have such a length and weight that will just prevent their touching the bottom of the stream and allow a very slight projection above the water surface to prevent any appreciable influence by the wind. There will necessarily be a layer of water between the lower end of the rod and the stream bed. As this layer is moving with a velocity less than the mean in the vertical, the rod, uninfluenced by it, will have a velocity greater than the mean, so that unless coefficients are applied in the computations rod floats give too high velocities. Rods of different lengths must, of course, be used for the different depths. A very satisfactory rod can be made of a piece of 2-in. round wood, to the bottom end of which is fitted a tin tube about 10 in. long, with the lower end closed. The tube should be filled with enough shot or sand to sink it to the proper depth. The rod should be oiled and painted to prevent its becoming water-soaked and sinking to a greater depth than desired.

In canals of unvarying section rod floats should, perhaps, give results as accurate as can be obtained by the natural use of current meters. However, in the

case of natural channels of irregular and rapidly changing sections, the error becomes much greater, and they should not be used.

Current Meters.

Perhaps the most commonly used and most generally applicable method of measuring the velocity of water in open channels at the present time is by the aid of current meters. Of these there are two common types, namely, screw and cup, typical examples of which are the Haskell and the Price meters respectively.

Velocity is not indicated directly by a current meter, but is obtained by the known relation between speed of the wheel and velocity of the water. As this relation is not the same for different meters, it becomes necessary to rate every meter made. Furthermore, the same rating will not hold for any meter throughout its life, so that the rating should be checked from time to time and a new rating table made up whenever the necessity for one becomes apparent.

The current meter and likewise the Pitot tube determines the velocity only at a point, whereas it is desired to know the mean velocity for the entire depth. However, if one takes a number of observations at different depths and plots the results in the form of a curve, plotting velocity against depth, the following facts can be learned:

First, the curve resembles a parabola whose axis is horizontal and at a distance below the surface of about three-tenths of the depth.

Second, the mean velocity occurs at about six-tenths of the depth of the stream.

Third, the mean between the velocities found at two-tenths and eight-tenths also gives the mean for the total depth.

These last two facts afford a ready means for determining the average velocity at any station by taking only one or two observations. Both methods are in common use, the .2 and .8 method giving perhaps slightly the better results. In making an observation by either method the number of revolutions is observed for a period usually of about 50 seconds. From the rating table the corresponding velocity is found. Thenceforth the manner of computing the discharge is the same as described for the float method.

One of the most serious errors affecting current meter measurements occurs when the meter is suspended at the end of a cable, as is often done. Unless some restraining device is used when the velocity is more than three feet per second, the meter is carried down stream a distance and raised somewhat in the vertical, and the observer has no means of knowing at just what depth he is making his observation.

There are many other possible sources of error affecting current meter measurements, some due to faulty design of meter, others due to carelessness on the part of the observer, but time does not permit of a full discussion of all these. It can safely be said that while current meters afford a ready and useful means of stream gauging, the degrees of accuracy attained in the results is not as great as is usually thought. It requires a very careful measurement to give a result within 5 per cent. of the true discharge, and an error of 10 per cent. or even 20 per cent. may easily occur.

One of the simplest methods theoretically for determining the velocity of flowing water is by converting the velocity head into a pressure head and then measuring this pressure. The conversion is readily effected by the simple expedient of presenting some obstruction to the flow. Accurate measurement of the resulting pressure, however, is not so easy. This measurement is usually made by balancing the pressure either by water column, as is done in the Pitot tube, or by some mechanical device.

Practically the only pressure instrument used at the present time is the Pitot tube. This instrument is rated and its manner of use is practically identical with that of the current meter. As to the practical value of the Pitot tube there is a most remarkable difference of opinion among leading hydraulicians.

Briefly summarizing, the writer would suggest the following methods of measurement as being the most practical for the purposes stated:

For gauging wide. shallow streams use current meters.

For gauging deep, narrow streams use current meters or salt solution method.

For gauging swift, turbulent mountain streams use salt solution method.

For gauging small streams use current meters or sharp-crested weirs.

For gauging open channels of uniform section use current meters or rod floats.

For gauging open channels, narrow, deep and of uniform section use color method, current meters, or rod floats.

For turbine testing use salt solution method or sharp-crested weirs.

For measuring the flow in sewers, or other closed conduits not flowing under pressure, use salt solution or color method.

For measuring flow in pipes under pressure use Venturi meter, Pitot tube, salt solution, or color method.

For measuring small discharges from tanks or reservoirs use sharp-crested orifices.

However, the application of these various methods is more or less elastic, the above being intended only as a general guide.

Mainly Constructional

East and West—From Coast to Coast

The recent advance of 10 per cent. in all lines of builders' hardware is attributed to increasing costs of raw material and labor.

The city inspector, Quebec, Que., during the week September 11 to September 16 issued building permits to the extent of $35,000.

It is reported that plans are under way for the construction of four steel freighters of 5,000 tons each at the drydock at Prince Rupert, B.C.

The McCallum Granite Company, Limited, has been incorporated with a capital of $40,000, head office at the city of Kingston, Ont. The company will manufacture and deal in monuments of all sorts.

"La Compagnie des Terrains et Constructions de Shawinigan Falls" has been incorporated with a capital of $24,500, headquarters at Shawinigan Falls, Que. The firm will enter the building trade and deal in all kinds of building materials, as well as carrying on other lines of business.

Wm. Camps, road commissioner for Scarboro Township, is building an 80-foot span concrete and steel bridge over the Rouge River at Hillside. The structure is along the line of permanent bridges being built all over the township. The work will be completed before the close of the season.

The city of Toronto is considering the replacing of the present sedimentation system of sewage disposal with

the activated sludge process. As the matter will involve an expenditure of some $5,000,000, they are going slowly, but experiments appear to justify a belief that the activated sludge process will be adopted.

The Willamette Iron and Steel Works, an Extra-Provincial Company, has been registered under the "Companies Act;" and is authorized to carry on business within the Province of British Columbia, its provincial headquarters being at Vancouver. The capital of the company is $600,000. Its head office is at Portland, Ore.

The contract for the construction of the model concrete roadway from Killaly Street to Sugar Loaf Hill, west of Port Colborne, Ont., has been awarded to the Ideal Construction Company, of Kitchener, Ont. Work is to be started at once, with a force of about 50 men. This is being built by the Canada Cement Company.

The Montreal Board of Control have under consideration the appointment of Mr. Henry Holgate as consulting engineer for the proposed hydro-electric development at the aqueduct. It is estimated that the installation of a new civic lighting system in connection with the development will cost $1,680,000, including an underground conduit system.

At a recent meeting of the Brockville, Ont., town council, a blue print of the proposed fountain to be erected on Court House Avenue in the spring to the memory of the late ex-Mayor John H. Fulford, was exhibited. The work is in the hands of the Atlantic Terra Cotta Company, of Montreal. The design, by Architect Raine, calls for a fountain 15 feet high from the first base and of symmetrical proportions. Starting at the lower portion and ascending are three basins, the first is 21 feet in diameter, the second 11 feet, and the top one 6 feet.

The plant of the Pacific Steel Products, Limited, located on Lulu Island, about one mile from Eburne, B.C., has been destroyed by fire. The plant was formerly known as the Dominion Safe Works and represented an investment of $110,000, a large proportion of which it is believed will be actual loss. The plant commenced operations under the new name only recently, but had a large number of contracts on hand, their products being bolts, nuts and similar iron and steel products, for which there is at present a large demand.

A committee of the Montreal Builders' Exchange is considering the Quebec Lien law, which is considered by many members to be unsatisfactory, especially from the point of view of the supply men, who have to give notice to the proprietors if they desire to protect themselves in relation to goods sold to contractors. This portion of the law is liable to cause a certain amount of friction, and is not generally acted upon. The committee is obtaining copies of the law in other provinces, in order to see whether a more workable Act cannot be passed in Quebec.

Several tenders submitted to the provincial government for work on the new parliament buildings at Winnipeg have been rejected, the prices being declared too high. Hon. Thos. H. Johnson, Minister of Public Works, stated that the government had decided to make certain changes in the plans in order to reduce the cost of the building. The rejected tenders were from a dozen or more contractors and covered various branches of the work. The tender of the Manitoba Bridge and Iron Works, however, for the dome steel was accepted at $169,000, their offer being the lowest

Part of the Petawawa road lying within the Pembroke, Ont., town boundaries, which was recently given a new dressing of stone by the town, under an arrangement with the Northern Development branch of the Ontario Government, is now being given a treatment of tarvia dressing under the direction of town engineer W. J. Moore, and a representative of the Paterson Manufacturing Company, Limited. This is being put on as a binder and is expected to preserve the roadway. It is the first tarvia to be used in Pembroke, and if it stands the test on this much-travelled piece of road it will likely be used extensively there.

The question of installing a sewerage system at Ford City, Ont., has become a pressing one, and a deputation of the councillors recently paid a visit to Whitby to look over the sewage disposal plant, pumping station and the system in general. During their inspection they were accompanied by T. Aird Murray, the designer of the Whitby system, and F. F. Fry, the builder of the sewage disposal plant. Mr. Murray explained everything in detail, showing the working of the whole plant. Next, the party proceeded to the pumping plant which is being installed beneath the roadway at Port Whitby in order to force the sewage from the section of the town which is too low for the gravity system to be used. After the inspection Mayor Montreuil, of Ford City, expressed his admiration of Whitby's splendid equipment and said he wished they might install similar water and sewage services at Ford City.

Personal

Mr. C. H. Dancer, former deputy minister of public works for Manitoba, has been appointed Winnipeg district engineer for the federal department of public works.

Mr. A. E. Pickering, manager of the Water and Light Commission of Sault Ste. Marie, Ont., has resigned to accept an important position with the Great Lakes Power Company.

Mr. Albert Sincennes, architect, is suing the city of Moncton, N.B., for $2,705, which he claims is owing for professional services in connection with the new city hall and market building.

Mr. J. J. Knight, contractor, of Bala, Muskoka, has received word that his son, Pte. James A. Knight, who went to England with the 3rd Division Cyclists, has been promoted to the rank of lieutenant.

Mr. J. W. Frazer, of Moncton, N.B., is again taking up his former profession of architect, now having had practical experience for some time as a contractor. Mr. Frazer is an associate of the Royal Institute of British Architects, and has had considerable experience in architectural work in the Old Country, as well as in Canada. He has carried out a large amount of ecclesiastical, school, domestic and general work, and is besides an expert quantity, building and land surveyor. For the present he will have his office at 132 Steadman Street.

Obituary

Mr. Edward Gurney, president of the Gurney Foundry Company, Limited, has passed away, in his seventy-second year.

Mr. Joseph Newman, of St. Catharines, Ont., a former member of the contracting firm of Newman Bros., died recently after a lingering illness.

Major W. A. Casey, of Victoria, B.C., has been killed in action, according to a message received from the War Office. Major Casey was a well-known civil engineer in that city.

Ex-Alderman Thomas Davies, who in former years was a citizen of prominence in Toronto's municipal life, has passed away after several months' illness. He is credited with being the originator of the Board of Control and of the city's present system of municipal government, and was also instrumental in bringing into effect the local improvement by-laws.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Guelph, Ont.
Bulk or separate tenders will be received until September 30th for the construction of sections 1 and 2 of Municipal Drain No. 1. Plans and specifications at offices of the Clerk, James Laidlaw, 25 Douglas Street, Guelph, and the Engineer, C. D. Bowman, West Montrose, Ont.

Hamilton, Ont.
Engineer E. R. Gray and Chief Engineer James Bain have been authorized to prepare plans for waterworks buildings and equipment, including a high duty triple expansion steam unit and steam turbine. Approximate total cost, $300,000.

Engineer Gray will also prepare plans of a reservoir, estimated to cost $200,000.

The City Council are considering the construction of a quantity of cement sidewalks, pipe sewer and asphalt pavement. Engineer, E. R. Gray.

The City Council have decided to lay a watermain on Main Street, and will start work in about one month. Approximate cost, $11,468. Clerk, S. H. Kent.

Hawkesbury, Ont.
The Town Council will receive tenders until 8 p.m., October 2nd, on the following:—(1) supply and installation of one electrically driven turbine pump, capacity 1,000,000 gallons per day, direct connected to 100 h.p. motor; (2) pump with capacity of 750,000 gallons, with 75 h.p. motor; pump of 500,000 gallons capacity, and 50 h.p. motor. Foundations will be constructed by Town. Clerk, M. Garcau.

Kingsville, Ont.
The Town Council propose to replace the watermain on Lakeview Avenue with a larger one, and will secure estimates. Clerk, George Pearse.

London, Ont.
The City Council will shortly call for tenders on the construction of sanitary and storm sewers. Engineer, H. A. Brazier. Approximate cost, $7,000.

Tenders on the construction of sanitary sewers on William Street will be received until October 4th. Engineer, H. A. Brazier. Approximate cost, $5,000.

Toronto, Ont.
The Board of Control will receive tenders until October 3rd on the supply of 20-inch cast iron pipe with castings and valves. Plans and specifications at office of the Works Department, City Hall.

Welland, Ont.
Plans are being prepared for waterworks extensions estimated to cost $3,000. Engineer, D. T. Black.

CONTRACTS AWARDED

Moncton, N.B.
The City Council have awarded a contract to Carritte, Paterson Company, Ltd., 89 Water Street, St. John, for the construction of macadam roadway on St. George Street. Approximate cost, $25,000.

Toronto, Ont.
The Board of Control have awarded the following paving contracts:—Godson Contracting Company, Manning Chambers, asphalt paving, $16,334; Grant Contracting Company, 50 Front Street East, concrete paving on four streets; Commissioner of Works, bitulithic paving, $1,571.

Railroads, Bridges and Wharves

Toronto, Ont.
The Provincial Hydro Electric Commissioners have prepared a report on the construction of a radial line from Port Credit to St. Catharines, via Hamilton, estimated to cost $9,360,360, inclusive of buildings and rolling stock. Engineer, F. A. Gaby, University Avenue.

CONTRACTS AWARDED

Chatham Township, Ont.
The Township Council have awarded a contract for construction of three steel and concrete bridges to the Sarnia Bridge Company, 176 North Street, Sarnia, and for two bridges to William Strange, Turnerville.

Public Buildings, Churches and Schools

Creemore, Ont.
Work on the proposed school will not start until the spring. The general contractors will do all trades.

Foxwarren ,Man.
A by-law has been passed authorizing the raising of $6,000 for construction of a school addition. Clerk of Consolidated School District No. 525, P. Highfield.

Guelph, Ont.
The Methodist Conference of Guelph District have passed a resolution favoring the erection of a Home for women and girls. President, Rev. W. Barker.

Joliette, Que.
In connection with the erection of an annex to the Court House, the general contract will do all work except roofing, which will be sub-let.

Kemptville, Ont.
The Provincial Department of Agriculture are having plans prepared for Agricultural School Buildings, estimated to cost $100,000. Architect, F. R. Heakes, Parliament Buildings, Toronto.

Medicine Hat, Alta.
Tenders on the erection of a school according to the revised plans will be received until October 1st. Approximate cost, $15,000. Architect, W. H. Bourne, Huckvale Block.

Rossland, B.C.
James Bowman will prepare new plans of the proposed school, and tenders will be called. Approximate cost, $75,000.

Simcoe, Ont.
The Board of Education will proceed with the erection of two schools if an additional grant of $20,000 is granted. Approximate cost, $40,000.

Tweed, Ont.
Ellis & Ellis, Manning Chambers, Toronto, are receiving new tenders on the erection of a High School, estimated to cost $25,000. Hollow tile, steel and brick construction.

Verdun, Que.
J. E. A. Benoit, 1200 Wellington Street, has prepared plans for an extension to the college on Gertrude Avenue for the School Commissioners, and tenders will be called this fall. Brick, steel and limestone construction. Approximate cost, $75,000.

Walkerville, Ont.
The architects for the proposed Parish Hall for St. Mary's Anglican Church are Crane & Ferguson, 15 Deacon St., Boston, Mass. Approximate cost, $20,000.

CONTRACTS AWARDED

Haileybury, Ont.
The High School Board have awarded the general contract for the erection of a school to P. H. Secord & Sons, Brantford, Ont. Approximate cost, $20,000.

Halifax, N.S.
In connection with the school which is being built on Yonge Street for the School Board, the contract for roofing and plastering has been awarded to the general contractors.

Hamilton,Ont.
The City Hospital Board have awarded the contract for electric wiring and fixtures for the Barton Street Hospital to R. M. Smith, 401 Barton Street, at $1,900.

Lachine, Que.
The contract for foundations required in the erection of two schools for the School Commissioners of St. Anges de Lachine has been awarded to Laplante & Company, 19 Sixth Avenue.

Laval De Montreal, Que.
In connection with the school which is being built, the contract for plumbing, heating, roofing and electrical work has been let to F. Turcot, Laval de Montreal.

Montreal, Que.
In connection with the school which is being built on Notre Dame de Grace

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The Relationship of Capital and Labor

AT many times in the world's history, the stability of great enterprises has been threatened, from various causes, but perhaps never has the prosperity and convenience of a section of a country ever been more endangered than by those eruptions and manifestations that make themselves felt in the form of industrial strikes. In recent years we have had many exhibitions of such crises, in some cases arising from a justifiable resistance to an unjust or intolerable state of affairs, but, unfortunately, in many cases culminating in a menace that has interfered with and more or less permanently undermined the safety and prosperity of a whole nation.

Perhaps never before have we felt more keenly the possibilities of dire results and upheavals in the commercial situation of any country than was exhibited in those few days last month when the railway employees of the United States threatened to throw up their jobs in default of a granting to them of several measures of industrial reform. The crisis was suddenly averted by the action of Congress under the whip and spur of President Wilson, in passing drastic legislation which complied, in the main, with the demands of the trainmen. Doubtless he justifies his action by the argument that such a dangerous situation justifies equally dangerous remedies.

* * *

The situation evoked nation-wide rebuke and scathing criticism from the daily and technical press. Apparently the high-handed action of President Wilson has not found favor in the eyes of free-thinking, broad-minded citizens of the United States. By some people, it is regarded as a most injurious measure, almost certain to be a future source of danger and insecurity. As an example, one contemporary engineering paper states, in commenting on the matter, that "the United States as a nation and all its citizens individually are greatly humiliated, politically and financially injured, and their future safety and prosperity dangerously menaced by the intolerable and unjustifiable action of the labor unions as represented by the trainmen's brotherhoods and by the selfish, drastic, and cowardly response of President Wilson and the Congress of the United States."

* * *

This is putting it pretty strong, but an analysis of the situation would appear to show it to be more or less justified. In the legislation that was passed there are certain significances of extreme import and certain considerations that demand careful thought and require action. Happily we in Canada have never been under quite the same difficulties and our labor organizations have real reason to be proud that in the greater crisis that has cast its shadow over the Empire, they have realized that the national spirit of patriotism, justice and freedom, is greater by far than the petty squabblings of an ill-contented labor class, and that they have set their minds resolutely to co-operate in terminating, to our advantage, the struggle in which we are engaged. But so closely are Canada and the United States interrelated that had the threatened strike materialized the effect on this country would have been only less in degree, and now that Congressional legislation has created this precedent in the settling of labor questions, there is no doubt but that in Canada the dangers in the path of those who would keep the peace between capital and labor are lying thicker than before.

* * *

That the United States Congress should pass such class-favoring legislation as they did seems perhaps inexplicable; that it should under duress favor four-tenths of one per cent. of the citizens of the United States at the expense of the other ninety-nine odd per cent. seems unaccountable. The reason for President Wilson's course, looking at it from our side of the line, we cannot understand, but it does appear to be clearly established that there has been created a precedent dangerous to the equilibrium of labor conditions. That the demands of a relatively small body of men should be granted unreservedly without hearing the other side of the story is bound to invite further demands of a like nature. What is fair for one is fair for another and with the present legislation unrevoked, labor is open to make more unreasonable requests and threaten more insane strikes, feeling that their power is so all-terrible that even Congress bows before its terror. Whatever advantage may accrue to the labor forces or under whatever bonds the railways may be placed, the gravest injustices in such a condition fall upon the shoulders of the public. The public is the big sufferer, because it

is an interference with public rights and it is they who pay. Railway companies, like all public utility corporations, are charged with developing the public interests and governmental control should be subservient to public benefits. But any playing into the hands of one side or the other is detrimental to the best interests of the nation, since it delivers it into the control of a few and in reality creates a monopoly. We believe, however, that the public have realized that their rights are not being respected, and that the reaction has come is evidenced by the unmerciful lashing by the press. Indications are that "abuse of power inevitably leads to loss of power."

* * *

From a social standpoint the granting of the demands of the brotherhoods is a flagrant violation of fundamental principles because it does not permit co-operation between the two factions. Certainly strikes should be made amenable to law and order, but labor questions must be decided on principles of equal justice for all and consideration for the legitimate rights of all. That the rate of wages should be fixed in arbitrary values upsets the basic principle that should govern such problems—the balance of supply and demand. Capital and labor if they are related on the highest plane of sociology will adjust themselves and find their level under that fundamental law. Laws should be enacted simply to ensure that this principle pertains, that it is not abused or its results exceeded, but legislation that attempts to set aside the co-relation of supply and demand by arbitrarily fixing a scale of wages without giving consideration to the multitude of details that are governing factors is action of the most high-handed order, at best but a sorry makeshift. That Canada may not feel the dangers of such action is to be hoped, but so related are the great labor brotherhoods that the pulse of the newly acquired power may quicken and spread, and it will require abundant foresight to stop it before its results become manifest.

Throughout the British Empire the feeling apparent between capital and labor appears, to a very considerable extent at least, to be that of co-operation in the interests of a great national cause—our war. But we must not forget for a moment that when this is won, we start another—the war of commerce. Is it too much to hope that the same happy conditions of mutual co-operation between man and master may prevail, that then, as now, the pride of both in the commercial advantages of our wonderful Empire may lead us to keep our petty, selfish ambitions still subservient to the common good?

The Making of Good Roads

FINISHING concrete roads by dragging heavy belting across the surface has recently been tried out in Wayne County, Mich., where the method of using the belt is as follows: Three pieces of heavy belting about ten inches wide and cut a few feet longer than the width of the road are used. The first is seesawed across the road as soon as the template has been used. The second belt is used in a similar manner, but not until water has just disappeared from the surface. After the concrete has stiffened somewhat, the third belt is run over the surface and leaves a fine grained, coarse, gritty texture. On the Fremont-Port Clinton Road in Ohio, contractors are using a strip of 8-ounce canvas 24 inches wide and 18 feet long in much the same manner. These finishing methods are apparently outgrowths of one practised in California, where a strip of pliable redwood, ⅜ inch thick, of suitable width, has been used to finish a concrete road surface. Although the value of these methods has not been demonstrated beyond dispute, indications are that they will prove to be more economical and satisfactory than hand floating.

As indicating the active campaign being carried on to popularize the use of concrete in roadmaking, the Portland Cement Association, during the occasion of a recent State Fair, conducted a demonstration in concrete road building involving the laying of about 600 square yards of concrete highway pavement. This particular demonstration was held on what had been designated as Good Roads Day at the Fair. Great interest was displayed in the demonstration. Quite a number of road supervisors and engineers from various counties in the state were present at the demonstration and so appreciated its worth that they insisted upon having the men under them present to see how concrete roads were built.

Good Demand for Metal Lath

The demand for metal lath is holding steady. One of the large manufacturers reports that his output is sold a considerable time ahead and there is every indication that the present year will be by far the largest year, in point of sales, ever known in the metal lath industry. The use of metal lath in stucco construction is increasing. A good portion of the increased demand is coming from smaller town and cities. There is also an increasing demand for metal lath to be used in the interior of residences. There is no prospect at the present time of any change in prices and the present indications are that the steel sheets from which metal lath is manufactured will not decline in price so long as the European war keeps up.

A Wider Outlook for the Engineer

As I see it, says a writer in The Engineering News, one of the greatest faults of the engineer is that he relies too much on his technical training, and confines himself entirely to too small a field, taking little interest in the affairs of the day outside of his own chosen profession and not mixing with clubs and organizations as other business men do.

Surely there is no business or profession which is more certainly founded upon sound business principles than is engineering. "Engineering is the theory of economy" expressed in a few words. No engineering business can ever be truly successful until it takes on a sound business system. We have often heard that an engineer is "a man who can do for one dollar what any fool can do for two." How can this be true unless, in addition to technical engineering knowledge, a man employs business methods in his calculations and transactions?

Most engineers are inclined to lack confidence in themselves when it comes to mingling with men of affairs, or else their outward demeanor does not show that this is not the case. We cannot expect to always talk "shop," and in our intercourse with men it is exceedingly important to our success that we be able to converse on other subjects. It is the big, broad man who accomplishes things in this day and age, and we must enlarge our field and become conversant with the events of the day.

The Importance of Cost Data on Municipal Work Carried Out by Day Labor

By Alvah E. Foreman*

THERE are certain branches of municipal work, such as street maintenance, street cleaning and garbage collection, upon which it is difficult to get satisfactory results when let by contract; so that a Works Department, equipped for carrying out work by day labor, is a necessary adjunct of a city's organization. If this department is organized so that it can produce efficient results, there is a tendency to enlarge its sphere of operations to include the laying of concrete sidewalks, water mains, sewers, etc.

In these days of keen competition, the successful contractors are those who keep accurate cost data, so that they will not only be in a position to prepare their estimates intelligently, but so that, **as the work progresses,** they may know just where the excessive cost or leakage is taking place, and be in a position to rectify it without delay. It is obvious that this is still more necessary on municipal work carried out by day labor, where there are many adverse conditions with which even the private contractor does not have to contend. For example, the city council sometimes considers it advisable to sacrifice price in order to place a contract for material with a local manufacturer; and again, men, to a greater or less extent, are employed for reasons other than their ability. The fact that they are taxpayers, or married men with families may take precedence over experience—a resolution along these lines being in force in the city of Victoria in 1915 and 1916—or again, they may be old men or others who through disability must be provided for by the city, and many other reasons less justifiable may also be cited. Notwithstanding these restrictions, the engineer is expected to carry out work as cheaply as the private contractor.

By keeping detail cost data, the increase in costs due to conditions over which the engineer has no control, are available; and what is more important, he is in a position to check all costs over which he has no control.

An accurate cost data system acts as a recording gauge and gives a permanent record of all variations in cost, and the advantages obtained are by no means limited to the engineer.

Cost-keeping Benefits the Taxpayer

The taxpayers, who may be looked upon as shareholders, are entitled to know if their money is being spent to the best advantage, and this is only possible when the costs are kept in detail. If they were so kept there would be less distorted and inaccurate information circulated, and consequently less criticism.

The aldermen, who may be compared to the directors of a company, are responsible to the people for the work done by the officials they appoint, and their task is much simplified and their confidence in the department increased—leading to more cordial relations—when they know that any information desired may be had at short notice, and is open for inspection at any and all times. If the work is being done efficiently, they should know it, and if not, they should know the reason why, and the engineer should be in a position to give it at once. This necessitates the keeping of detail cost data.

The foreman who is industrious and produces satisfactory results knows that there is a permanent record in the office which will assure him steady work with the city, and which will be of service should he apply for a position elsewhere—a record that will stand between him and any person wishing to have him dismissed from personal animus.

The greatest benefactor, however, is the engineer himself. It keeps him in touch continuously with every detail of his work, and he can at once pick up any increase in cost, locate the cause, and have it remedied. While his other duties may prevent him from visiting the work regularly, still he is better posted than if he did so and was without the information obtained from the cost data. He knows which foreman's work is exceeding a reasonable cost, and what is more, the foreman knows he knows it. The very fact that detail costs of each job, with explanatory notes, are on file in the office for future reference has an excellent moral effect upon the foremen. It not only helps the competent man, but is a convincing argument against the incompetent foreman who claims that he has been dismissed through spite or favoritism, as it is difficult to argue against data kept over an extended period.

One foreman may be a first class man on dirt excavation but poor on rock work, or in bad ground; another may be equally good in both. This is apparent at once where detail information is kept, and the foreman can be placed where best adapted.

Encouraging Foremen to Co-operate

The engineer should encourage his foremen to take an active interest in their work, and should engender an esprit de corps and friendly rivalry among them.

One of the best methods, in the writer's opinion, is by supplying them weekly with detail cost data. They then acquire the habit of figuring out the cost of their work to enable them to check up the weekly reports, and the information obtained is an incentive for them to try to steadily reduce the cost by improved methods. It is surprising the excellent suggestions that are made by the foremen from time to time, and one gets the benefit of the brains of all the foremen instead of those of possibly a few, and the efficiency of the entire department is increased thereby.

The engineer, besides being technically trained, and having the ability to handle men, should have a sound business education. He has control of the expenditure of large sums of the taxpayers' money, and he should be able to inaugurate up-to-date business methods in his department, and see that they are carried out. Among other things is the keeping of accurate detail cost of work. The system must be simple but effective, and the cost of introducing and carrying on must be a reasonable percentage of the value received. When once started every sub-division, whether in detail or more general, must be kept accurately; otherwise it is worse than useless; it is misleading,

* Assistant City Engineer, Victoria, B.C.

because the very fact of going into details implies accuracy.

It must not be expected ,however, that the keeping of detail cost data is of itself the engineer's panacea. The data must show that satisfactory work **is being accomplished** at prices that compare favorably with those for which contractors would do similar work, and just as a detector is first required to find a leak and then a mechanic to carry out the repairs, so the function of detail cost data is fulfilled when it locates the leakage or losses, and an experienced man is then necessary to apply the information obtained, to get the desired results.

There is no reason why a Works Department cannot carry out construction as cheaply and satisfactorily as a private contractor, provided the engineer has the proper organization and is given the same privileges of purchasing material and employing labor as the latter.

Day Labor in Victoria

The amount of work done by day labor in the city of Victoria, B.C., has steadily increased until now practically all is being carried out by this method. The work includes sewers, water works, sidewalks, asphalt pavements, boulevard construction and maintenance, parks, garbage collection, street cleaning, etc. The total expenditure on day labor work in 1915, notwithstanding the financial stringency, exceeded half a million dollars, and the payrolls alone for work carried out by day labor in 1912, 1913, and 1914 averaged over $700,000 per annum.

The writer during the last four years has been introducing and improving upon a cost data system in connection with the above mentioned work. Starting with sewer construction the scope has been enlarged until now it covers practically all work done by day labor. Some of the more important reports are illustrated herewith. Tables 1, 2 and 3 show, respectively, the cost of work for 1915 on concrete sidewalks, asphalt surface and garbage collection. The reports are compiled and made out by a cost data clerk with the assistance of a timekeeper in his spare time. The engineer who lays out the work takes the measurements for quantities. The foremen are given reports weekly showing the average labor cost for the work, the average cost for the preceding week, and the average cost to date. On concrete work for road base, however, the weekly reports show the quantities of cement, sand and gravel estimated, and the quantities actually used, which should tally closely.

It is impressed upon the foremen that the first requisite, and one which is insisted upon, is first class workmanship; and the only costs they are concerned with primarily are labor costs. They are neither to waste nor go short on material. The foremen make any explanatory notes they consider necessary and return the reports which are then filed in the office.

One foreman's weekly reports on sewer work showed a steady increase in cost, while the gang appeared to be good workers. An investigation showed that the foreman was gradually employing old friends, and a shake-up resulted in a reduction of from 25 to 30 per cent. in labor costs. After one or two lapses his services were dispensed with.

Another foreman's report showed that the work was costing too much. He was conscientious and a hard worker, and his gang appeared to be working steadily; but after being given every assistance it was seen that he had not the ability to lay out his work and handle his men to get the desired results, and he had to be replaced.

In another case, of laying concrete base, the work performed by a good gang was found to be more costly on some streets than upon others, and for no apparent reason. It was found upon investigation that the material settings on streets of considerable grade were not placed to the best advantage, necessitating wheeling up hill with increased cost of handling aggregate to and from the mixer.

The above causes would have been difficult to locate without detail cost data.

TABLE I—CONCRETE SIDEWALK CONSTRUCTION FOR 1915

By-law No.	Street.	From	To	Started.	Completed.	Foreman.	Estimated cost.	Actual Cost. Total.	Material.	Labor.	Plant rent	Misc. bills.
483	Douglas	Fisguard	Herald	5 2 15	24 2 15	Mitchell	....	$942.25	$292.55	$605.75	$43.95	....
434	Bank	Oak Bay	Cowan	7 4 15	15 4 15	Mitchell	....	896.35	530.31	324.45	41.60	....

Concrete Sidewalk Construction for 1915 (Continued).

Cost Per Sq. Ft. Material.	Labor. Grad'g.	Labor. Laying	Plant rent:	Total.	Sidewalk Constructed. Area, sq. ft.	L'gth, ft.	Width, ft.	Grading. Rock Excavation. Total cost	Cu. yds.	Per cu. yd.	Dirt Excavation. Total cost.	Cu. yds.	Per cu. yd.	Fill Over cut). Total cost.	Cu. yd.	Per cu. yd.	Miscl. Total cost.
$0.075	$0.107	$0.049	$0.011	$0.243	3,874	242	16	$249.25	58	$4.30	$96.65	275	$0.35	....	...	....	$68.75
0.069	0.012	0.028	0.008	0.117	7,660	1,532	5	3.00	2	1.50	6.75	7	0.97	$51.75	120	$0.43	31.50

Concrete Sidewalk Construction for 1915 (Continued).

Labor Cost Per 100 Square Feet.

Forms	Cement men.	Sand men.	Gravel men.	Concrete graders.	Cement finishers.	Foreman.	Mixer engineer.	Concrete wheelers.	Tampers	Miscl.	Hauling.
$0.26	$0.21	$0.12	$0.41	$0.26	$0.31	$0.26	$0.16	$0.34	$0.16	$0.36	$0.33
0.69	0.09	0.11	0.23	0.23	0.13	0.31	0.21	0.48	0.09	0.21	0.06

Concrete Sidewalk Construction for 1915 (Continued).

Rates of Wages. Per Eight-Hour Day. Foreman.	Mixer engineer.	Cement finisher.	Laborer.			Cost of Materials. Cement per bbl.	Sand per cu. yd.	Gravel per cu. yd.			Remarks.
$4.00	$2.75	$2.25	$2.00	....	...	$2.00	$1.35	$1.50	....	....	High cost account of rock.
4.00	2.75	2.25	2.00	....	....	2.00	1.35	1.50	....	....	

All sidewalk construction this year done as relief work, inexperienced as well as experienced labor being employed at reduced wages, and special prices for material. Base 3½ in. thick, of 1:3:6 concrete. Top ½ in. thick, of 1:2 concrete mortar.

Costs at the Corporation Shops and Yards

The cost of all work at the corporation blacksmith and machine shops is kept; and all the detail costs of keeping horses at the city stables; and charges for work and teams made against the departments in the same way as is done by outside firms, the charges being sufficient to cover depreciation and maintenance as well as labor and material.

A plant account is kept and all jobs charged a rental for tools and equipment used; small tools on a basis of five per cent. per month, and larger plant at a rental sufficient to cover maintenance and depreciation. Foremen sign for and must return all equipment to the city yards, no matter in what condition.

TABLE II—REPORT ON ASPHALT PAVING, 1915

By-law No.	Street	From	To	Started	Completed	Foreman	Estimated Cost	Actual cost	Total actual cost per sq. yd.	Asphalt Paving Laid: Binder Area sq. yds.	Binder Thickness ins.	Binder No. of boxes	Surface Area sq. yds.	Surface Thickness ins.	Surface No. of boxes
361	Market	Douglas	Rose	1-6-15	4-6-15	Bevan		$1,514.85	$0.413				2,479	2	418
350	Sylvia	Boyd	Dead end	7-6-15	7-6-15	Bevan		545.30	.661				837	2	160

Report on Asphalt Paving for 1915 (Continued).

Details of Cost: Labor Cost at Plant: Binder Total	Binder Per sq. yd.	Surface Total	Surface Per sq. yd	Total Total	Total Per sq. yd	Material Cost at Plant: Binder Total	Binder Per sq. yd	Surface Total	Surface Per sq. yd	Fuel & Supplies Total	Fuel & Supplies Per sq. yd	Total Total	Total Per sq. yd
...	.....	$124.95	$0.052	$124.95	$0.052			$652.85		$31.45		$684.30	$0.277
..	.....	44.25	.052	44.25	.052			225.70		15.55		241.25	.287

Report on Asphalt Paving for 1915 (Continued).

Details of Cost (Continued): Laying Asphalt on Street: Hauling Mixture, plant to street Total	Hauling Mixture Per sq. yd	Binder Total	Binder Per sq. yd	Surface Total	Surface Per sq. yd	Fuel & Supplies Total	Fuel & Supplies Per sq. yd	Total Total	Total Per sq. yd	Overhead Charges: 50% credited to paving plant maintenance Total	50% Per sq. yd	50% credited to paving material Total	50% Per sq. yd	100% debited to by-law Total	100% Per sq. yd
$62.90	$0.025	.	....	$134.30	..	$10.40	.	$144.70	$0.054	$298.60		$197.60		$494.60	$0.2[illegible]
41.00	.058	....	....	43.25		5.05	.....	48.40	.057	100.45	.	66.95		167.40	.2[illegible]

Report on Asphalt Paving for 1915 (Continued).

Rates of Wages. Per Eight-hour Day. Street Gang: Foremen	Roller engineers	Rakers	Smoothers	Laborers	Cost of Materials: Asphaltic cement, per ton	Sand, per cu. yd	Gravel, per cu. yd.	Mineral dust, per ton	Fuel oil, per imp. gallon	Remarks
$3.50	[illegible]	$3.50	$3.25	$2.25	$10.92	$0.85	$1.25	$10.43	$0.035	Asphaltic cement f. o. b. Chicago. Victoria duty paid

All worn out tools are there scrapped and sold for junk. All the larger pieces of plant, such as concrete mixers, compressors, rollers, rock crushers and motor trucks, are numbered and a separate account, showing charges in detail, is kept for each. When the maintenance cost of any equipment becomes excessive, the cause either lies with the mechanic in charge or it is time to dispose of the machine and purchase a new one. Table No. 4 is the 1915 report on road rollers.

Besides the detail reports, curves are plotted for garbage collection, pumping costs, engineering expenses, etc., with costs, or, quantities and costs, as ordinates, and the months of the year as abscissae; from which the data from year to year can be compared and any undue variation noted.

A comparison of the costs of oiling streets for the years 1913, 1914 and 1915, will illustrate what can be accomplished by improved methods of handling; this being directly attributable to the interest taken in the work on account of the detail cost data kept. In 1913 the cost per square yard was 1.12 cents, but this included labor, material and teaming charges for oiling only. Dust removal was charged to street cleaning and no sand was used. The oil was delivered in drums, hoisted onto a platform and emptied into horse-drawn tank wagons.

Cost of Oiling Streets

In 1914 the cost per square yard was 1.23 cents, including cost of oil and sand and all labor, teaming and plant rental charges for removing dust, applying oil and spreading sand. The cost for oiling only was 0.81 cents per square yard. Part of the reduction was due to the lower cost of oil, but about half was due to improved methods of handling. The body of the motor truck was replaced by a 600 gallon tank, which the city had on hand, and the oil, which was delivered in tank scows, was dumped directly into the tank. By this means we were able to oil from four to five times the yardage covered in the same time by a team in 1913. The sand was delivered to the streets, rehandled with carts and spread by hand, but we found it difficult to keep pace with the oiling machine.

In 1915 the cost per square yard was 1.09 cents for carrying out the work as enumerated for 1914. The cost of oil was slightly lower and wages were reduced, but there was also an improvement in handling the

TABLE III—REPORT ON REMOVAL OF GARBAGE, 1915.

Month	Force Employed Daily: No. of Foremen	No. of Sub. Sta. men	No. of carts with drivers	No. of can men	No. of motor trucks with drivers	Expenditure: Men's wages	City stables bill	Plant rent	Light	Water	Miscl. Supplies	Towage	H. S.	Total
January	1	2	17	15	2	$2,596.20	$553.41	$420.90	$8.25	$37.75	$56.42	$549.00	$23.90	$4,245.83
February	1	2	19	14	1	2,076.50	611.18	316.90	4.30	73.85	30.71	549.00	7.70	3,670.14

Report on Removal of Garbage for 1915 (Continued).

Garbage collected, cu. yds.	Cost per cu. yd. dumped at sea	Cost per capita per annum	Details of Collection, Etc.: By Carts to Woodlands Road Sub-Station: Total	Per cu. yd.	cu. yds.	By Motor Truck from Woodlands Road to Central Wharf: Total	Per cu. yd.	By Carts to Walnut St. Sub-Station: Total	Per cu. yd	cu. yds	By Motor Truck from Walnut St. to Central Wharf: Total	Per cu. yd
2,782	$1.52	...	$647.95	$1.00	649	$137.35	$0.21	$925.45	$1.21	762	$137.35	$0.18
2,782	1.31	..	547.70	0.95	573	128.00	0.23	786.00	1.10	713	128.00	0.18

Report on Removal of Garbage for 1915 (Continued).

Details of Collection, Etc. (Continued): By Carts from Houses to Central Wharf: Total	Cu. yds.	Per cu. yd.	By Motor Truck from Houses to Central Wharf: Total	cu. yds.	Per cu. yd.	Towage from Central Wharf to Sea: Total	cu. yds.		Garbage Collected from Business District from which Revenue is Derived:	Cu. yds	No. of cans	Rate per can	Revenue
$746.72	542	$1.37	$667.40	482	$1.39	$549.00	2,782	$0.198	$308.30	347	1,858	$0.08	$148.64
987.88	993	1.00	177.55	149	1.19	549.00	2,782	0.198	344.80	353	1,914	0.08	145.12

Report on Removal of Garbage for 1915 (Continued).

Rates of Wages: Foremen per month	Sub-Station men per month	Carters per eight-hour day	Can men per eight-hour day	Motor Truck drivers per month	Motor Truck drivers per day	Remarks
$110.00	$75.00	$3.00	$3.00	$90.00	$4.00	Capacity of garbage cans is 2½ cu. ft. or 4 cans to the cu. yd.
99.00	71.25	2.50	2.50	80.00	3.50	Capacity of garbage carts is 2¼ cu. yds., or 18 cans.

TABLE IV- ROAD ROLLERS, 1913 TO 1915 RECORD

Year Purchased	DESCRIPTION	Cost Price	Valuation 1913	Valuation 1914	Valuation 1915	Valuation 1916	1909 to 1912 Estimated	Rentals Earned 1913	Rentals Earned 1914	Rentals Earned 1915	Rentals Earned Total	Maintenance 1909 to 1912 Estimated	Maintenance 1913	Maintenance 1914	Maintenance 1915	Maintenance Total
1908	Ruston Proctor 8-Ton	$3320.00	$2988.00	$2500.00	$1100.00	$ 900.00	$1200.00	$ 395.00	$ 965.00	$1367.50	$3927.50	$450.00	$186.96	$497.64	$143.95	$1277.92
1909	Waterous 12-Ton	3362.00	3025.00	2750.00	1300.00	1000.00	900.00	172.50	1005.00	637.50	2715.00	250.00	67.25	119.86	103.89	541.00
TOTAL		$6682.00	$6013.00	$5250.00	$2400.00	$1900.00	$2100.00	$ 567.50	$1970.00	$2005.00	$6642.50	$700.00	$253.61	$617.50	$247.81	$1818.92

Table IV also shows the following: $6,682, plus maintenance $1,818.92, less earnings $6,642.50, leaves actual cost or value of rollers, $1,858.42. This compares with the 1916 valuation given in another column of Table IV, namely $1,900.

sand. A hopper which feeds onto a rotating disk, as shown in Fig. 1, was made at the corporation machine shop, and attached to the rear of a motor truck. The truck went direct to the bunkers for sand and thus saved double handling of the material. However, as the oil sprinkler covered a greater area than the sander, it was necessary to use carts to sand the balance of the yardage oiled in a day. It was found that the sanding machine spread the material more quickly and more uniformly than it could be done by hand and used less sand per square yard.

Up to the present we have been using hand brooms for dust removal, as objections were made to the use of street sweeping machines on account of annoyance from dust. We now propose using the rotary brooms at night to try if possible to reduce the cost.

Next year we shall lay out the entire work beforehand so that where possible a day's work will be divided between macadam streets, which have been oiled this year, and which will, therefore, require less oil and more sand; and the newly resurfaced and dirt streets, which will take more oil and less or no sand; so that the sander can cover as much as possible of

Fig. 1—Sand sprinkler in action, Victoria, B. C.

the yardage oiled and thus eliminate carts. We hope by this means to reduce the cost of oiling to one cent per square yard, and the saving will be directly due to the information obtained from the detail cost data.

The city has nearly completed, by day labor, the North West trunk sewer at an estimated cost of $365,000, about a mile and a half of which is in rock tunnel. The cost of this work was steadily reduced until during the last three months the labor cost per lineal foot of tunnel was about 35 per cent less than it was during the first three months, the foremen themselves being surprised at the reduction they were able to make, and at the low cost of work towards the close.

Day Labor Less than Contract

It was first thought advisable to have the 36-inch steel pipe outfall laid by contract, and tenders were called for accordingly. The work, however, was done by city forces and completed for less than half the price submitted by tender, and the results were so satisfactory that the syphon under Selkirk Arm was also laid by day labor, and the work carried out successfully at a low figure. It has taken two and a half years to construct this sewer, and it will be completed for over $75,000 less than the estimate as prepared by the engineers of the three municipalities interested.

Concrete sidewalks are being constructed for from 30 to 40 per cent. less than they were costing in 1911 and 1912. Sheet asphalt is being laid for considerably less than the price paid the contractor in 1914. There has been a steady reduction in the cost of collection and disposal of garbage. These are examples of what can be accomplished by keeping detail costs, and others could be given.

To inspire confidence in others an engineer must have confidence in himself; and to have confidence in himself he must not only have a general knowledge of his work, but he must be conversant with the details. The more he masters these, the more efficient he becomes. This is accomplished largely by keeping detail cost data and by having a filing system such that he can find what he wants, when he wants it. The latter is most important, but is outside the scope of this paper.

Finally to recapitulate, the direct results of keeping detail cost data on municipal work are:

To supply the engineer with incontrovertible evidence against mis-statements.

To inspire the aldermen and taxpayers with confidence in the department, with the attending benefits.

To make the foremen better and more efficient workmen.

To insure a large saving of the taxpayers' money.

And to increase the engineer's knowledge and incidentally his earning capacity. And as such it has an appreciable moral effect as well as a monetary and an educational value.

Mr. Kenneth G. Rea, architect, of Montreal, has been instructed to proceed with the plans and specifications of the Westmount new City Hall, the cost of the building not to exceed $200,000. The design of Mr. Rea won a competition for the building, but its execution has been delayed owing to financial matters.

The total fire loss in the United States and Canada for the first four months of this year amounted to $97,555,420.

Sheffield Sewage Disposal Works

THE disposal of the sewage of Sheffield, a city approximately the size of Toronto, takes place in settling tanks and contact beds. A scheme has been prepared for treatment in percolating filters and for aeration and filtration of the effluents. A great deal of experimental work has also been carried on with reference to the purification of sewage by aeration, activated sludge, etc. A description of the existing system and results of experimental work are incorporated in a paper read by John Haworth, manager of the Sheffield sewage disposal department, before the conference of the Association of Managers of Sewage Disposal Works (England), which is reproduced below:—

The area of the city of Sheffield is 24,886 acres, and the estimated population is 477,228. The present sewage disposal works serve this population, together with that of the outside districts of Blackburn (780 persons), part of Wortley rural district (9,000 persons), and Dore (1,732 persons), the sewage from which is treated under agreements with the city council. The normal dry-weather flow is approximately 15,000,000 gallons per day, of which 3,500,000 gallons consist of trade waste waters, but this volume has been considerably exceeded since the war commenced, owing to munition work.

The whole of the city is drained by gravitation to the main disposal works, situated at Wincobank, with the exception of a small proportion which is dealt with at the Tinsley works, which adjoin the main works.

In the year 1884 works were designed by Mr. G. Alsing, and constructed on part of the present site at a cost of £44,730 (including land) for the purpose of treating the sewage by lime precipitation. These works were opened in 1886, and were designed for a flow of 10,000,000 gallons per day. For some years the sewage was treated during eighteen hours only out of the twenty-four each day, and the sewage was allowed to pass to the river in an untreated condition during the remaining six hours at night. Later the treatment was made continuous.

Rapid Growth Necessitates Extensions

At the time of their opening the works were considered to be of an excellent type, and they no doubt produced a great improvement on previous conditions. The rapid growth of the city, the population of which increased from 304,720 in 1886 to 352,760 in 1896, and the introduction of the bacteriological systems of treatment, and the demand for treatment of storm water, necessitated further extensions and improvements.

In the year 1900 the corporation obtained powers to purchase further areas of land, and 246 acres in all have been acquired for sewage disposal purposes. A scheme for the extension and remodelling of the works was therefore prepared and carried out by the city engineer (Mr. Charles F. Wilke, M. Inst. C. E.). The scheme was placed before the local government board in 1904, construction commenced in 1905, and the first section was put into operation in 1909. The scheme was completed in 1914, at a cost of £298,143, including lands actually occupied by the works.

The old works, except the shell of the main building, have practically disappeared. The works now consist of four sets of catchpits, equal in capacity to 1/48th of the dry-weather flow. Two sets are remodelled from the old pits, and are fitted with screens for hand raking, and fixed dredgers for cleansing purposes. The two new catchpits, of modern type, are provided with mechanical screens and an electrically driven travelling dredger for removal of the deposited solids directly into railway wagons.

Settling Tanks

The settling tanks are seventeen in number, with a capacity approximately equal to the dry-weather flow of sewage. They are operated on the continuous flow principle, and have proved efficient in removing the solid matters.

The deposited sludge is passed by gravitation to two sludge wells in the main buildings, from which it is pumped by three centrifugal pumps to underdrained drying lagoons, where it is air-dried to a moisture content of 80 to 85 per cent. The sludge is then removed by rail to a tip six miles lower down the valley, about 1,200 to 1,500 tons per week being thus disposed of.

Contact Beds

After leaving the settling tanks the settled sewage is treated on 46 acres of primary contact beds and then discharged to the river. Twenty-nine and one-half acres of the contact beds are divided into half-acre units.

The medium employed is screened clinker and slag, laid to an average depth of 4 ft. 3 ins. in graded layers. The under-drainage, laid on concrete floors, consists of tiles, chiefly of semi-circular section, placed in rows 10 feet apart.

The remaining 16½ acres of beds are similar in construction to those described, but are divided into approximately one-acre units, each provided with special outlets, so that they may be used either as ordinary contact beds or as storm filters by streaming the sewage through continuously.

The capacity of the works is 64,500,000 gallons per day, but the main conduit, etc., are constructed for a flow of 110,000,000 gallons per day, extension thus being provided for.

The volume of sewage treated is accurately measured by an installation of four 48-in. Venturi meters.

The main buildings contain boilers, engines, dynamos, catchpits, sludge wells and pumps, valve-rooms and workshops.

The laboratory and office form separate blocks of buildings.

A scheme for secondary treatment, to consist of percolating filters, with power-driven distributors, humus tanks, and accessories, for the rapid aeration and filtration of the primary effluents, has been prepared. The scheme has been submitted to the Local Government Board, but was postponed during the war.

A scheme for pressing the sludge is also under consideration.

Experimental Work on Aeration, Activated Sludge, Etc.

A short description of some experimental work carried on at Sheffield is now presented. Although these experiments are by no means complete, and have been retarded on account of shortage of staff and pressure of work due to the war, the description may be of in-

terest and furnish some matter for useful discussion.

At the period when the main extension scheme was approaching completion it was considered probable that some form of secondary treatment of the primary effluents might be needed.

While the primary effluents are usually incapable of putrefaction, at times colloidal solids separate out on standing, and they are particularly liable to this effect on account of the large volume of trade wastes, containing iron and other metallic salts, hydroxides and mineral acids discharged into the sewers, and present in the sewage at the outfall works. Experiments were therefore commenced about four years ago in order to determine the most suitable and economical methods by which the primary effluents from the contact beds might be rendered at all times satisfactory. An experimental plant was constructed, consisting of tanks, pumps, motor, etc., for the purpose of conducting the necessary experiments.

Aeration

It was found that, on standing in contact with air, opalescent and cloudy effluents became quite clear after about twenty-four hours. Experiments were therefore made in order to bring about, if possible, the rapid deposition of colloidal and other solid matters with subsequent clarification.

These experiments consisted of: (1) aeration by jets of air; (2) aeration by forcing air through porous substances, such as land tiles and silica bricks; (3) aeration by causing the liquids to fall in sprays; (4) aeration by rapid treatment on percolating filters of varying depths; (5) sand filtration; (6) precipitation by chemicals.

All these methods produced the effects desired to a greater or less extent, but by means of the percolating filter effluents of high purity, clear and free from colloidal matters, were obtained.

Primary effluents have been regularly treated in this manner at the rapid rate of 800 to 900 gallons per day per cubic yard of material with satisfactory results over a period of at least four years.

The following chemical results may be taken as typical:—

	Parts per 100,000	
	Liquid treated	Sprinkler Effluent
Oxygen absorbed, four hours' test	2.51	0.68
Nitric nitrogen	....	0.72
Dissolved oxygen test. Oxygen absorbed in five days at 18.3 degs. Cent.	....	0.63
Suspended solids	....	Traces only

The effluent, when diluted with tap-water in the proportion of 4 effluent plus 5 tap-water, and the mixture aerated at 14.5 degs. Cent. (equal to two parts dissolved oxygen per 100,000), and then incubated for five days at 18.3 degs. Cent., invariably absorbed less than 2 parts of oxygen per 100,000 and were therefore well within the Royal Commission standard.

Application of Activated Sewage Methods

The scheme for secondary treatment referred to in the general description of the disposal works was based upon the results of these experiments. It may, however, be pointed out that while the early experiments which were made by forcing air through porous substances, such as land tiles and silica bricks, did not yield such hopeful results, there was an incentive to continue the experiments, inasmuch as attention had been drawn to the use of activated sludge in combination with aeration. Consequently it was thought that useful information might be obtained by applying activated sludge to the treatment of primary effluents.

In two of the experimental tanks, fitted with diffusers, sludge was activated by the usual method. In one tank primary effluents and mixtures of these effluents with settled sewage were dealt with, and in the other settled sewage was treated.

The results have proved both interesting and instructive. In the case of the tank treating primary effluents with settled sewage, deposition of colloidal matters is obtained, but, bearing in mind the large volumes of this liquid which can be dealt with on the percolating filter and the greater simplicity of the process, no advantage would be gained by adopting the former.

	Parts per 100,000	
	Liquid treated	Effluent
Oxygen absorbed, four hours' test	3.47	1.03
Nitric nitrogen	....	0.25
Dissolved oxygen test. Oxygen absorbed in five days at 18.3 degs. Cent.	....	1.31
Suspended solids	....	Traces only

The effluent, when diluted with tap-water in the proportion of 4 effluent plus 5 tap-water, and the mixture aerated at 14.5 degrees Cent., and then incubated for five days at 18.3 degs. Cent., invariably absorbed less than 2 parts of oxygen per 100,000, and was thus well within the Royal Commission standard.

Treatment of Settled Sewage

In the case of the tank treating settled sewage, good results are also obtained.

The effluents are usually, with normal sewages, excellent in character, as the analytical results indicate, and the sludge separates rapidly and distinctly. The alluring prospect of a possibility of purification without filters has led to further investigations.

	Parts per 100,000	
	Liquid treated	Effluent
Oxygen absorbed, four hours' test	4.67	1.69
Nitric nitrogen	....	0.40
Dissolved oxygen test. Oxygen absorbed in five days at 18.3 degs. Cent.	....	0.21
Suspended solids	....	Too small to estimate in 250 c.c. of the liquid.

The effluents, when diluted with tap-water in the proportion of 4 effluent to 5 tap-water, and the mixture aerated at 14.5 degs. Cent., and then incubated for five days at 18.3 degs. Cent., with a few exceptions absorbed less than 2 parts of oxygen per 100,000 and were within the Royal Commission standard.

Results

Briefly, the following are the results arrived at:—

(1) Well-clarified effluents are usually obtained which are within the commonly accepted limits of impurity allowable.

(2) It is found that discharges of acid trade wastes, such as occur in the Sheffield sewage, destroy the efficiency of the sludge for a time. On one occasion a particularly strong discharge resulted in the activity being destroyed, and aeration for several weeks was required before clarified effluents could again be obtained. This inhibitory action is more or less pronounced, and consequently great care is necessary to render such abnormal discharges neutral in character, and to equalize their flow so as to render such sewage amenable to purification by this process. A still more important

point must be considered—namely, the effects of discharges of trade effluents containing and consisting essentially of chemical solids of heterogeneous composition upon the activated sludge.

(3) The porous tiles became choked after a few months' use, owing to dust and grease in the compressed air, and also by bacterial masses growing through the pores of the tiles. This latter fact has also been proved in connection with the Pasteur-Chamberland porous porcelain tube filter.

(4) Uneven aeration occurs by reason of unequal porosity of the tiles.

(5) Tiles have cracked, with the result that the air escapes at one place, and the tank has had to be stopped for repairs. This unsatisfactory feature in the use of porous tiles requires serious consideration.

These unsatisfactory features lead one to the conclusion that, while sewage may be purified by means of activated sludge, the mode of application leaves room for much investigation and improvement before its practical utility is proved. Experiments have therefore been made in connection with devices for the aeration of liquids without the use of porous media, and in this direction some of the latest experiments will now be described.

During a discussion on this question with Mr. F. Scudder, F.I.C., F.C.S., of Manchester, he described to me a series of experiments on the aeration of crude sewage which were made by him in 1881, in collaboration with the late Dr. Angus Smith, and called my attention to an apparatus designed for the oxidation of oils, etc., devised in the year 1880 by Dr. Storer, and which was used in Angus Smith's experiments. As a result of this, and with the aid of valuable suggestions by Mr. Scudder, apparatus has been constructed which promises satisfactory results, of which several small types may be seen in operation.

Apparatus for the Aeration of Liquids

The apparatus consists essentially of a narrow cylindrical tube placed vertically and fitted with a central spindle, bearing either an archimedean screw or a series of suitably shaped propeller blades. A number of the blades are within and others projecting below the lower end of the tube. The top of the cylindrical tube is placed at a suitable depth beneath the surface of the liquid to be aerated. On rotating the spindle at a rapid rate the liquid is merely circulated down the cylindrical tube, but on the insertion of a small air pipe within the edge of the cylindrical tube a large volume of air is sucked in and distributed into the liquid at the lower end of the cylinder. The mixed water and air rise up on the outer side of the tube ready to flow in again, and thus the aeration is continuous.

The apparatus is at present experimental in character, but as a mechanical means for circulating the sludge and at the same time giving abundant aeration, has so far proved to be simple and effective without many of the disadvantages to which aeration by forcing of compressed air through porous slabs, etc., is liable.

It should be observed that two functions are performed by the air in the activated sludge process as now operated—viz., primarily, the supply of oxygen for maintaining the bacteriological and chemical action and efficiency of the sludge; and, secondly, the agitation of the sludge with the liquid.

As only a small proportion of the air is used for oxidation, and the larger proportion for circulation, it becomes questionable whether it is economical to use compressed air for purposes of agitation, or if mechanical agitation, which would carry in probably the minimum amount of air necessary, would work as efficiently as the more expensive compressed air plant.

Mechanical Agitation

With this aim two further experiments were devised:—

(1) A series of perforated ordinary steam pipes was laid at the bottom of a small tank and connected to the compressed air supply. Over the pipes, approximately 2 ft. of clean clinker or slag, broken into approximately ¾-inch cubes, was laid. The tank was then filled with settled sewage, and air bubbled through for about five hours.

The resulting effluent was found to be clarified, non-putrescible, and in all respects a satisfactory one. A partially septic and black tank liquor treated by this method becomes bright and clear after one hour's aeration, and after four to five hours is amply purified.

One of the tanks has been in daily operation for about nine months, and continues to give good results.

	Parts per 100,000	
	Liquid treated	Effluent
Oxygen absorbed, four hours' test	4.97	0.92
Nitric nitrogen		1.15
Dissolved oxygen test. Oxygen absorbed in five days at 18.3 degs. Cent.	....	1.89
Suspended solids		Too small to estimate in 250 c.c. of liquid.

The effluents when diluted with tap-water in the proportion of 4 effluent to 5 tap-water, aerated at 14.5 degs. Cent., and then incubated for five days at 18.3 degs. Cent., with a few exceptions absorbed less than two parts of oxygen per 100,000, thus being within the Royal Commission standard.

(2) The second experiment consisted of a small iron tank having a semi-circular section at the bottom. A shaft was fixed lengthwise through the tank, and to it were attached two hollow paddles of special shape, so arranged that in the lowest position the paddle nearly touches the bottom of the tank and in the upper position it is approximately at the top of the tank. The tank was charged with humus washed from material taken from a contact bed together with sewage, the proportionate volume of humus being 25 per cent. of the sewage. When the paddle is rotated the blades leave the liquid at the surface and trap a small volume of air, which is carried into the liquid and discharged therein. Thus the mixture of humus and sewage is kept continuously in motion, and a definite quantity of air is discharged into it by each revolution of the paddle. The paddle is revolved fifteen times per minute.

After several weeks' operation the humus was found to become fully activated, and during the last six months crude sewage has been treated daily with satisfactory results, as the analytical table indicates.

	Parts per 100,000	
	Liquid treated	Effluent
Oxygen absorbed, four hours' test	4.81	1.17
Nitric nitrogen		0.66
Dissolved oxygen test. Oxygen absorbed in five days at 18.3 degs. Cent.		0.57
Suspended solids	....	Too small to estimate in 250 c.c. of liquid.

The effluents, when diluted with tap water in the proportion of 4 effluent to 5 tap water, aerated at

14.5 degs. Cent., and then incubated for five days at 18.3 degs. Cent., invariably absorbed less than 2 parts of oxygen per 100,000, thus being within the Royal Commission standard.

The results of these two experiments show that the aeration by minute bubbles of air, such as through porous tiles, is unnecessary, and that mechanical circulation, combined with minimum aeration, is efficient. Both these experiments are still in operation.

General Conclusions

The general conclusions drawn from the experiments which have been described may be summarized thus:—

(1) That a normal sewage may be purified by the activated sludge process.

(2) That trade wastes may interfere seriously with the process.

(3) That further investigation is needed with respect to modes of application of the sludge to the sewage, periodical removal of the surplus sludge and the effect of such removal on the continuing results of purification methods of aeration, costs of plant and upkeep, before older plants and methods can be abandoned.

(4) That skilled control of the process will be essential.

(5) That, while the resulting sludge is undoubtedly richer in nitrogenous organic matter than ordinary sewage sludge, it remains to be proved by actual agricultural trials that such nitrogen is in a form suitable for the ready assimilation by plant life, and that as a fertiliser its superiority over humus can be established, as up to the present humus sludge derived from sprinkler filters, which is also richer in nitrogenous organic matter than ordinary sewage sludge, has not been appreciated by the agriculturist as a fertiliser, in spite of its availability in large quantities at many sewage works in this country during recent years.

Protection of Concrete Against Sea Water

Conclusions reached after an exhaustive search of the available technical literature on the subject of the destructive action of sea water on concrete, and a scientific analysis of a particular case by experimental study to determine the effect of various elements in the problem, are given in a report by Mr. W. Watters Pagon.

A summary of these conclusions is given in the following paragraphs:—

(1) The addition of puzzolana in some form is widely practised in Europe, and appears to be theoretically correct. It has not been tried in America, to the author's knowledge, but is worth an exhaustive test. The amount should not be over one part for each part of cement, nor less than one-half part.

(2) Waterproofing with substances that combine chemically with the free lime ought to be successful, and is well worth testing.

(3) Between extreme high and low tides the concrete surfaces should be faced continuously, without joints, with about 3 inches of 1:1½ or 1:2 mortar, made with sand as specified below, well cured before coming in contact with the sea water. The facing must be placed simultaneously with the backing.

(4) The cement should be low in lime and alumina and contain as little gypsum as possible.

(5) Sand must be silicious, uniformly graded from fine to coarse, with not less than 50 per cent. nor more than 70 per cent. passing through a No. 20 sieve, and not more than 3 per cent. passing a No. 100 sieve, and must have no organic matter coating the grains. It must be free from roots and easily disintegrated grains, such as feldspar, shells, limestone, mica, etc. It should be washed free from clay, and should show a tensile strength of 1:3 specimens not less than 85, 90, 95 and 100 per cent. of the strength of standard Ottawa sand of the same consistency, using the brand of cement that is to be used on the work, at ages of one, three, seven and twenty-eight days respectively.

(6) Where concrete must be exposed to sea water without mortar facing, gravel should not be used. Broken stone should be hard, durable, trap, granite or other dense, hard, insoluble stone. It should not exceed three-quarters of an inch in size, and should be free from crusher dust, sand, dirt, organic matter or other foreign substances. The mixture should be 1:1½:3 or 1:2:4, or should be proportioned for maximum density.

(7) Pure fresh water should be used in sufficient quantity to permit the materials to be well puddled and spaded, so that no later surface treatment or patching will be required, but not sufficiently to materially retard the setting of the cement. Care must be exercised, however, to prevent the formation of laitance or pockets of neat cement or very rich mortar.

(8) Forms should be tight to prevent leakage of cement or, where concrete must be submerged immediately, to prevent contact with the sea water.

(9) Facing should be reinforced with steel, well covered with mortar, and securely anchored to the backing.

(10) No surface treatment should be given.

(11) The work should be allowed to harden two weeks, if possible, before coming in contact with sea water. Two months is better.

(12) Sea water work should never be done in cold weather, with temperature below 40 degs. Fahr.

(13) Where possible, precast, mortar-faced blocks cured in damp sand for at least one month should be used. The facing should extend back at the joints to prevent saturation of the backing. The joints should be pointed with 1:1 mortar of coarse sand.

(14) The most durable surface will be obtained if granite or other dense stone be used as facing. This should not be less than six inches thick, anchored back with wrought-iron clamps, and pointed with 1:1 mortar of coarse sand and cement as noted above.

(15) On mortar or concrete surfaces the growth of barnacles, moss, etc., will frequently afford protection.

Speed Checks at Grade Crossings

On a California road experiments are being conducted with the use of grade checks or bumps constructed in the pavement to necessitate the reduction of speed of vehicles at railroad crossings. These are being placed for a short distance on each side of the tracks, so arranged as to demand careful driving and to eliminate a possibility of speeding. These bumpers in one particular case are rounded ridges, nine to twelve inches high above the surface of the roadway and are approximately four to six feet wide at the base and two feet at the crown. Where there is a double roadway only the right hand roadway is thus marked. It is stated that crossing accidents have been materially absent since the installation of the bumpers.

Other suggestions for checking speed at grade crossings are dips in the roads and the use of sand beds for a suitable distance.

Factory Building Vibration

Building vibration has an evil effect on occupants, machines and output and to a certain extent upon the structures themselves. With the idea of determining the actual conditions, a Boston firm has been seeking information from professional men and manufacturers, and although a comprehensive report has not yet been issued, certain information has been issued in a preliminary report which indicates some of the features of this problem. The replies to the questions sent out are widely divergent in experience and opinion, but the conclusions are interesting as indicated by the following abstracts of the report:—

The effect of coincidence between the natural frequency of vibration of a floor and that of a source of disturbance is well illustrated by the following experience in connection with the testing of a small engine upon a floor of timber construction: At a speed of about 550 r.p.m., the intensity of the floor vibration was so great that it was impossible to work in the draughting room located on the same floor more than 100 feet away; but this effect entirely disappeared when the speed was either increased or decreased by about 50 r.p.m. When the disturbing force is represented by a number of machines at practically the same speed, the effect may be like that of dancers upon a floor or soldiers marching over a bridge, and prove most destructive to the entire structure if the step time coincides with its natural pitch.

Obviously, most vibrations are the result of several components, and records must be made of not only the vertical but also the horizontal components, both longitudinally and crosswise of the building. Vibration recorders are modelled on the principle of the seismograph; the three-component type developed by Maurice Deutsch, of New York, and Prof. Elmer E. Hall, of the University of California, is much lighter than the ordinary seismograph, thus rendering it capable of recording vibrations of higher frequency. The records are made on a rotating drum covered with smoked paper by a recorder which separates a given vibration into three components, two horizontal components at right angles to each other and the vertical component. These three components are recorded simultaneously.

Type of Construction Influences Vibration

Obviously, the type of construction and the extent to which it permits or prevents vibration must be considered. The context of many of the quotations which have been selected referred to buildings, usually old, entirely unsuited to the requirements. Hence the resulting vibrations. Other correspondence shows with equal clearness that the absence of vibrations is due to the rigidity of the structure, to foresight in the placing of certain machines on solid foundations, to the proper cushioning of others and such arrangements of duplicate machines operating at the same speed as to avoid cumulative effects.

The general experience is that severe vibration tends to tire the workmen and make them nervous, with the result that they become irritable and inefficient. The plant manager of a large concern says that he has had four different clerks leave because they could not stand the vibration of the building. During the past nine years, about eight or ten men left because they found they could not do a day's work on the chipping hammer floor because of vibration.

An instructive contrast in conditions and results is shown in a letter from a consulting engineer. A mill in which weaving apparatus was originally located was of the old-fashioned type, but rather light, and the looms could not run more than 120 picks per minute without serious difficulty with breaking threads. In the new plant the design speed was about 145, but through error it was made 160. When the plant was started, in spite of the superintendent's vigorous complaints, no trouble was experienced, and the mill is at present running at this speed with less loss, so far as breakage is concerned, than was experienced in the old mill at far slower speed, and, of course, with greatly increased output. It is claimed that this was owing solely to lack of vibration.

Solid foundations apparently insure greater output. A case is cited of one machine which was first placed directly on the floor and vibrated very badly. To overcome this vibration, the floor was cut away around the machine and a foundation put under it. The increased output is claimed to be almost forty per cent., due to the fact that the operator can take measurements with the machine running when there is no vibration, but was unable to do so where the vibration was so great. Apparently, the quality of the work is also considerably improved. An engineer says that perhaps one of the reasons why some of the English and other foreign fabrics are better than American fabrics is that greater attention has been given to the construction of their mill floors, which are surprisingly free from disturbing vibrations.

Effect of Vibration in Machine Shops

The general effect of vibrations in machine shops is clearly expressed by the following quotation: "With the heavier tools where there is an excessive amount of vibration, the depth of the cut is limited, and we cannot use the full power of the tool. It produces a sort of chattering which marks the work and limits the amount of stock which can be removed in one cut." An industrial engineer states that there is one point where the vibration of buildings is not considered sufficiently, and that is in transmission of power by shafting. The losses caused by vibration in such transmissions are considerable.

The trouble caused by reciprocating machinery may be eliminated by proper cushioning or bracing. Where machinery creates more or less vibration due to shock, an effort should be made to use either a massive construction to absorb the shock or else put in direct supports which will transmit the vibration to a point below the foundation. Statements regarding the comparative merits of different types of construction cover a wide range of experience and opinion. In the case of a knitting mill in which considerable trouble with combination steam and joist construction buildings was experienced, it was found that buildings of modern reinforced concrete having heavy machines on the first and second floors showed no sagging, nor is any vibration noticeable.

The replies include a great number of statements from consulting and designing engineers, ranging from the opinion that there are no material advantages in a reinforced-concrete building to the following: "The owners had some mill construction buildings in use before we built the reinforced-concrete buildings. Some sections of the former vibrated like drums, but we believe the concrete construction has proven quite free from vibration."

Destruction of Macadam Roadways

The nature of the wear in stone roads and the manner in which loads contribute to their deterioration — The effect of water

MUCH discussion is centred round the adaptability of macadam roadways under modern conditions. In past years this type of road was considered a standard method of highway design, and even yet there is a greater mileage of macadam laid than of any other surfaced type, although there are indications that in some forms it is unsuited to the nature and conditions of traffic that prevail today. Much has been written about the way in which a macadam road is made, may be made, or should be made. It is interesting to develop the way in which such a road is destroyed. The causes contributing to the destruction of a road of this nature and the way in which they act, are discussed in a paper read before the Institution of Municipal and County Engineers (England) by Mr. T. W. Arnall. This paper is reproduced in the following paragraphs:—

Many studies are available of the way in which a macadam road is made, may be made, or should be made; the way in which such a road is destroyed may be a useful addition.

It will be assumed that the road is made up of fragments of broken stone, of various sizes, compacted together into a more or less solid mass having as small a proportion of voids as possible, and perhaps bound or slightly cemented together by dust or mud. It will be convenient to give but small consideration to positive cementing materials such as Glutrin, Rocmac, and others more or less soluble in water; and to others not soluble in water, such as tar, Plascom, bitumen, and the like. It will be further convenient to assume that the foundation is quite hard and unyielding; if it be not so, the agencies which are destroying the macadam must be supposed to extend into the foundation, which thus becomes part of the structure to be destroyed.

It must first be emphasized that it is impossible to make a solid mass with rounded stones of any size. If round marbles of any size, but all of one size, are thrown loosely into a box, there may be 40 per cent. or more of empty space, and no amount of shaking or arrangement can possibly reduce the voids to less than 26 per cent. of the total. This proportion is quite independent of the size of the marbles; if they are 1-inch diameter they cannot fill more than 74 per cent. of the total space, and they cannot fill more than 74 per cent. of that space if they are too small to be separately visible. This supposes that they are all of one size, but obviously if the box be first filled with big marbles, other smaller ones can be placed in the cavities, and there is room for still smaller ones in the cavities then left. The voids can thus be reduced without limit by introducing smaller and still smaller balls into the cavities. It is, however, essential that the sizes be properly graded; it is of no use trying to fill the interstices with balls of only one size, however small they may be; the spaces must first be filled with balls of as big a size as possible, and the smaller ones kept back until no larger ones will go in. (See Figs. 1 and 2).

For round balls substitute rounded stones of any size or shape, and the argument is substantially true; with oval or potato shaped pieces the voids may be reduced below what would be given by round balls, but the voids cannot be altogether abolished, however small the rounded pieces may be, and however carefully they may be graded and packed.

This argument breaks down when applied to flat-sided stones, free from rounded edges and corners, and it would follow that the road should be made up of such flat-sized, sharp-edged pieces; but even then they must still be graded into suitable sizes. A sett pavement in which the equal-sized pieces are separately placed by hand is not under consideration; a macadam road is made up of random sizes and random shapes; mixed in some way and compacted together as solidly as possible by rolling. Many of the edges and corners are rubbed off in the process, and many of the stones are broken; it is truly a rough and unmechanical process, but it has to serve since no better one is known.

Effect Produced by a Load

The effect produced by a load placed upon a stone forming part of the surface of such a mass may be readily traced. If the stone is resting upon one other only, it must sink or roll over until it bears also upon two or three others; each of these in turn must rest upon at least three others, so that in the result the pressure of the load is passed downwards to the foundation in the shape of a cone, with a rather broad base at the bottom. The cone cannot be closely defined, principally because there is not enough known about the shape and arrangement of the stones composing it. Their size has not much to do with it. If they are all smooth and round like marbles or bicycle balls they are easily pushed aside, and the base of the cone must be a very broad one. If they are flat and parallel, say like pieces of slate laid flat, there will be no side-long pressure, and the base may be no larger than the last piece resting on the foundation. If the pieces are still flat and parallel, but not laid flat, the cone will appear in some form or another, and result in a broadened base. In general it will perhaps not be far out to assume that the slant side of the cone is at an angle of 45 degrees; its base will then have a diameter equal to twice the thickness of the macadam. If this is 6 inches the pressure of an isolated load on the top will be spread over a circle about 1 foot in diameter, and it may therefore be concluded that a steady load concentrated on a small area on the top produces but a moderate pressure per square inch at the bottom.

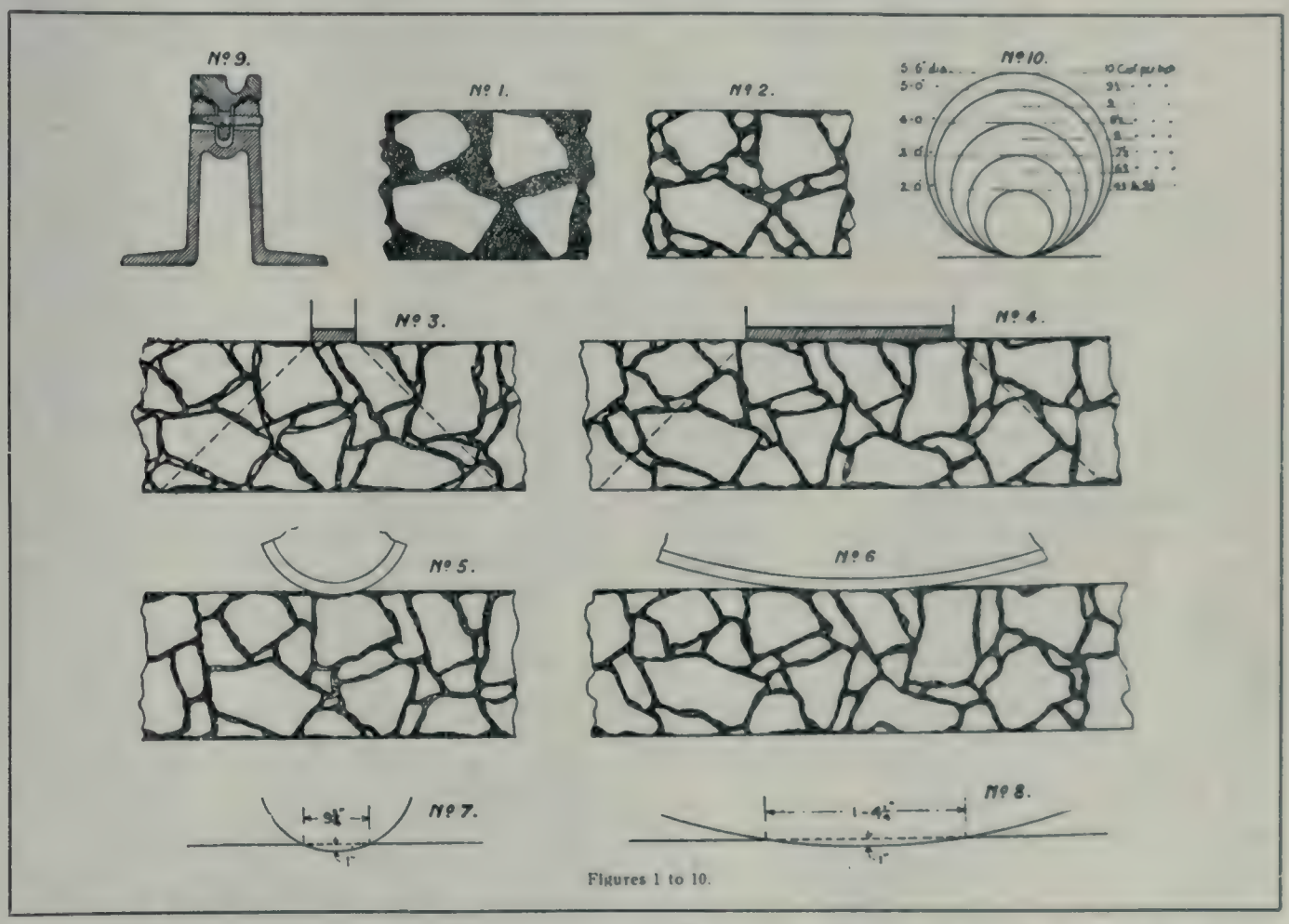
The way in which the cone would be modified when the load takes the shape of a wheel is indicated in Figs. 3 and 4. A 3-inch tire will give a cone about 15 inches wide at the bottom, or five times the width of the tire; an 18-inch tire will give a cone about 2 feet 6 inches wide, or something less than 1¾ times the tire width. The proportionate width of the cone is much less in this latter case than the other, and it must obviously be less in proportion the greater the width of the tire.

Size of Wheels

From Figs. 5, 6, 7 and 8 it is evident that the size of the wheel will have an important influence on this

question. If the road were perfectly hard the wheel would touch it in a thin line only, and its diameter would be immaterial, but some sensible depression must be produced on a macadam surface; the line of contact becomes widened out into a sensible area, and with any given degree of sinking, the larger the wheel the larger this area of contact becomes. To fix ideas, Fig. 7 shows that if the sinking is 1 inch, the length of contact will be about 9¾ inches with a wheel 2 feet in diameter and 1 ft. 4¼ ins. with a wheel 5 ft. in diameter, as in Fig. 8. In other words, the maximum pressure under a 2-ft. wheel will fade away to nothing at a distance of about 5 inches from the centre, and at a distance of about 8 inches in the case of the larger wheel. Hence it is certain that for a given load the sinking of a large wheel must be less than that of a smaller one, for the same pressure is spread over a greater surface, and its average intensity must be reduced in proportion. The mischief done to the road must also be reduced in something like the same proportion; hence the reason for the loadings of the wheels of heavy motor cars as fixed by the Board of Trade Rules, which are summarized in Fig. 10. Roughly speaking, the permitted loads per inch of width of the tire are proportional to the square root of the diameter of the wheels; they are not exact probably, because the practical dimensions of inches and hundredweights would lead to awkward fractions if more precisely worked out. As the length of contact varies in the same proportion with different wheels, the net result is that the different loads and wheels give the same average load per square inch upon the surface.

The cone is not shown in Figs. 5 and 6 because there is no definite spot on the surface to start it from; whatever the depression caused by the load may be, it dies away gradually to nothing at the point where the wheel leaves the ground. Still the cone is there, nevertheless. In Figs. 3 and 4 its sides are bounded by a definite crack starting at the surface, passing somewhere between the stones big and little, and tapering away in thickness as it nears the bottom. In Figs. 5 and 6 the crack is replaced by an indefinite looseness among the stones, perhaps aggregating in amount to the definite crack met with in the other case. The only way to prevent the formation of these cracks is for some of the material to escape sideways out of the cone and close up the crack as fast as it is formed. But in the absence of cavities into which this material can escape, this amounts only to pushing the crack into another place, or probably making many little cracks instead of one big one. That there is such a sideways tendency to escape is well seen in a pulpy road; the rut formed by a heavy loaded wheel is plainly due to a lifting at the sides as well as to a sinking under the wheel. Often it may be seen in front of a roller at work on a thick coating—the mass rises as a flat wave in front, to be forced down again as the roller moves over it. In any case there is no salvation, whether the view of one big crack is taken or a multitude of small ones; whichever view is taken the destruction of the material goes on just the same.



Figures 1 to 10.

The Nature of the Wear

It therefore appears that a load cannot be applied at any place on the macadam surface without pro-

ducing a cone of some sort below it in which the macadam is further compressed; also, if the load is sufficient to cause any sinking whatever of the surface, a crack will be formed between the cone and the unloaded parts of the mass. As the load moves this crack and all the commotion below move along with it, and the whole mass, from the top to very near the bottom, is set in motion in its turn. In this movement the stones, big and little, are forced into new positions. Not one of them moves until it is pushed, and if it is not forced into a cavity already formed, it is forced against something else which opposes the movement. If this obstacle does not yield the pressure may be great enough to break it. It is easier to displace or to crush a small stone than a large one, and the smaller it is the more easily it is dealt with. The net result of the movement under the passing load is that the whole mass is being ground up into smaller fragments; the larger pieces get their corners and edges broken off, and the angular, flat-sided pieces of the original mass become like rounded pebbles. The moving load makes these bigger pieces act like the pebbles in a cement-grinding mill; the smaller pieces are broken down to sand, and the sand is ground down to mud, or dust, according to circumstances.

There is a principle at work here which is worth a closer study, and it is perhaps best brought out by considering what happened to some tramway rails laid in Birmingham in 1882. They may appear to have little to do with a macadam road, but the experience gained by them was so clear and definite that it will be a useful help in dealing with the present subject. A section of the rail is shown in Fig. 9. It was a steel rail in pieces 10 yards long, supported on and fastened to closely spaced cast-iron sleepers 2 ft. 11 ins. long by steel keys, two to each sleeper. The sleepers were solidly bedded in concrete in the usual way, and the cavity inside them was also solidly filled with concrete. Attention must be fixed upon the successive pairs of bearing surfaces—first the bottom of the rail and the top of the sleeper; next the bottom of the hole in the rail and the bottom of the key; next the top of the key and the top of the hole in the sleeper; lastly, the bottom of the sleeper and the top of the concrete. The theory of the arrangement was that when the rail was worn out it could be easily removed, a new rail keyed to the sleepers in its place, and the whole structure would then be as good as new.

These expectations were not realized. The only wear expected was that on the top surface, and it was found to be the least important of all. Much greater was the wear on the bottom of the rail and the top of the sleeper, and the sleeper wore more than the rail. There was further wear between the key and the rail, and between the key and the hole in the sleeper. Then the surface of the concrete suffered. Leaving the bottom of the sleeper out of account, it will be seen that there was wear going on at seven different surfaces that had not been provided for, and long before the rail was "worn out" in the ordinary way the wear on these other seven surfaces gave serious trouble. It will be seen that they were all one behind the other, somewhat like the links in a chain. An electrician would say that they were arranged in series, and the same current of destruction had to pass through them all. There was not much to measure at any one surface, but the aggregate was sufficiently imposing.

Wear is Not Concentrated

The stability of such a structure depends upon the stability of every part of it. Consider the first three mentioned pairs of surfaces. If wear takes place at one of them, that pair is loosened, and, as an inevitable consequence, the other two pairs of surfaces become loose also. As in a chain pulled tightly, if one pair of links becomes loose every other pair of links necessarily becomes loose also. It cannot be that all are tight except one; they must either be all tight or all loose. In this case looseness of any one of the pairs of surfaces below the street level meant that grit was constantly getting in between them; every passing car crushed this grit, wearing away the surfaces, and making room for fresh grit to enter as soon as they were parted again. The frequent presence of water ensured this ground-up stuff being washed away and fresh abrasive material being brought into its place. The looseness of the rail caused the sleepers to become loose; water filtering into the bottom was violently surged to and fro as the car passed over the top. There could not have been much water to begin with, but there was always enough to completely fill the space below, and its scouring effect could have been no greater if it had been 10 feet deep.

There are four points to be emphasized in this experience, as follows:—

(1) The wear on the top surface was the least important of all.

(2) If one of the other pairs of surfaces became loose, all the others became loose likewise, and opportunities were set up for fresh wear taking place at every one of the surfaces.

(3) The smaller bearing surfaces suffered most. The bearing surface of the keys was only about a quarter of a square inch at the most, but each was as important to the stability of the whole as one of the larger surfaces.

(4) The presence of water greatly increased the mischief. It was under pressure and in motion. It was always bringing fresh grit into position, and washing away that which had been ground up into mud, and was no longer capable of withstanding any pressure or of packing any vacant spaces.

Every one of these points is immediately applicable to what is going on in the destruction of a macadam road.

(1) The wear on the surface is the least important of all.

(2) If a crack forms and makes some parts loose, all others behind them in the direction of pressure necessarily become loose also.

(3) The small pieces suffer most. The large pieces can carry no pressure unless the small ones support them and a pressure which is sufficient to break any one of them may at the same time break scores of others behind it. The blow must be carried on from one piece to another.

(4) Water greatly increases the mischief. It cannot be kept out of such a porous mass. It is put in motion by every passing load, swilling away the smaller particles which might act as packings, and so taking away the support of the large ones, which have to withstand the shocks. It acts as a lubricant and makes movements easy that would otherwise be impossible.

Excess of Water Injurious

The mention of water perhaps makes it convenient to point out that its mischievous effects appear to arise when it is in excess. Wetness must not be confused with dampness. Dampness holds fine particles together; it tends to prevent their movement, and so may have a beneficial effect on the road. Damp sand

tipped out of a cart will often hold together in lumps. It has no distinct "angle of repose." The sides of the lumps will stand vertical, and even overhang, so that there must be a real tension between particles. Nothing of this sort is possible with either dry or wet materials. If they are perfectly dry, the "angle of repose" may be about 45 degrees. If they are perfectly wet, it may be very little, and if there is any movement in the water it may vanish altogether; the sand may settle down to a dead level at the bottom of the water. It is obvious that this has important consequences on the stability of macadam, for cracks and cavities filled with water cannot be violently closed up under the traffic without that water being forced out, carrying the finer parts of the mass into new positions. If the mass is merely damp, these cracks and cavities are not full of water.

In addition to water the effects of clay have to be considered in many, if not in most, places. It is not mud, although it may be a constituent of the mud. A little mud mixed with water may settle, and leave the water perfectly clear; a little clay mixed up in the same way may take days, or even weeks, to settle, and whatever does quickly settle is pretty sure to be sand and not clay. It is a decomposition product of feldspar, and is therefore a constituent of most of the road-making stones used in the country. The change in the feldspar does not often effect the strength or value of the stone, and yet so much of it as has actually been changed into clay is readily washed off the surface of a freshly broken stone. Break the stone again and fresh clay may be washed off the newly-broken surface. In certain stones this may go on without limit; the finer the rock is broken or ground up the greater is the area exposed, and the greater is the supply of clay that can be washed out of it. This process is probably a frequent cause of the supply of clay, which is seldom absent from street mud; the clay makes it of a greasy, slimy nature, and tends to cause it to bake into hard cakes as it dries. Down below the clay acts as a lubricant, as a kind of wet grease, helping in every action tending to make the stones slide upon or rub against each other. It goes wherever the water goes, and makes movement easy under loads that would be quite incapable of shifting a dry, gritty mass.

Formation of Potholes

A fairly general sign of the destruction going on is the formation of potholes. For some reason or another a soft place exists in the macadam, perhaps because of a segregation of the smaller, and therefore the weaker, stones; perhaps because the rolling has been less thorough there than elsewhere, as against a manhole, or against the granite edge of a tramway where the paving has caught up the roller before the macadam was properly consolidated. The surface at such places is quickly worn or beaten down into a definite hole which holds the water. When all around is dry, this place is kept in a pulpy condition. If any water is visible in the hole it is certain that all below is thoroughly soaked and in the worst possible condition to carry traffic. The bottom of the hole usually shows comparatively large angular stones; the smaller ones and the mud and grit are all washed away; probably much of this has been done by the upward rush of water from below, squeezed out of the cavities near to but not under the hole. On the surface the rolling settles most of the larger stones so as to show a flat side upwards; in a pothole the stones are not in this position. Most of them show sharp angular points upwards, which are easily broken off by ironshod wheels, or easily shaken by the grip of rubber tires. In either case the conditions lead to a greater wear and tear at the bottom of the hole than on the adjacent surface.

A hollow place in the road is a kind of mechanical equivalent to a flat place on a car wheel, and it is well known that a very small flat has a most surprising effect. A flat an inch wide on a 31-inch wheel makes a bump that can be heard 500 yards away, and yet when this flat meets the rail the axle drops less than the 100th part of an inch. So likewise, when a wheel meets with a depression in the road, the hammer-like blow given to the bottom of the hole seems out of all proportion to the minute drop in the axle which caused it. It is so because the drop is not the free drop of a falling body under the action of gravity; the downward acceleration is due to the energy of the whole load stored in the deflected springs and suddenly released on the small mass of the wheel; the downward acceleration for a small space may be thirty or forty times that due to gravity alone. There is here quite sufficient reason for the destructive effects on this already weakened and sodden macadam.

But there is generally a still further mechanical effect. If the speed is great enough the upward push given to the wheel on the forward side of the hole takes place so quickly that the wheel is thrown upwards to a greater height than that from which it fell, to fall again and meet the normal surface at some point further on. The bump has become a jolt. At this second place there is a blow nearly as severe as that received at the bottom of the hole, and thus a second hole is quickly formed in advance of the first one. This, again, gives rise in its turn to a third hole, and so in a short time one pothole becomes the cause of many others being formed. They are spaced at pretty regular intervals, and there is no doubt that the intervals would be quite regular if the conditions giving rise to them were regular likewise.

Effect of Rubber Tires

The peculiar destructive effect upon the surface produced by rubber tires has not yet been referred to. The rubber may be easily shortened in one direction if left free to expand in another. Referring to Fig. 5, it is evident that there is no load upon that part of the tire which first comes in contact with the ground. As the wheel moves on this part becomes loaded, the load increasing to a maximum when the part in question is under the axle, dying away again to nothing as it leaves the ground at the back of the wheel. As soon as the load comes on the rubber is compressed in the direction of pressure, and must expand sideways to precisely the same degree. But the friction on rubber is enormous; as soon as it comes in contact with a stone on the surface, that stone is firmly gripped and must move along with the rubber which is expanding in one direction because it is being compressed in another direction. Thus the stones in front are pushed forwards, at the sides they are pushed outwards, until the axle comes over any one of them. Then the movement is reversed; the stones in the centre are gradually pulled back, and those at the side pulled inwards into something like their old position as the rubber recovers itself on escaping from under the load. The importance of this process arises from the fact that no stone displaced is ever pulled back into its old place. Not one of them can be violently pushed forwards or sideways without at the same time disturbing multitudes of smaller ones which are not in contact with the rubber at all, and are therefore free to take up new

positions. This prevents the stones ever reaching their old positions as they are pulled back again. The passing tire leaves most of them lying loose on a disintegrated surface. It is commonly said that the loose stones are "sucked" out of the ground; it would be better to say that they are "shaken" out. Every one of them has been pushed in one direction and the next instant pulled back again, but in the meantime the bed on which it lay has been broken up, and it now lies loosely upon instead of being bedded in the surface.

Destruction by Heavy Motor Cars

Motor buses call for special mention, since the destruction wrought by them is greater than their weight or number would account for, even when full allowance is made for the heavy loads and high speeds. Beyond these things are the facts that the busses are similar in structure, and at any given part of their route they tend to travel at the same speed. At any given hole the same jolt is experienced every time; the wheel comes down on the same place as the one before it did; and whatever mischief is caused by one is exactly repeated by every other one that travels along the same track. Any variation in the load, size of wheels, or speed, would tend to prevent accumulation of effects, but as this would interfere with standardization of structure and regularity of working, it appears that the results must be accepted as inevitable. All the advantages of uniformity and standardization belong to the owners of the vehicle; the defects and consequent mischief are passed on to the owners of the road. An arrangement of this sort should be capable of some more equitable adjustment.

Interstitial Wear

It is certain then that the destruction of a macadam road is not a question of wear on the surface. A wheel may pass by and leave no track behind, but many of the small stones below have been crushed in carrying the load. The smaller these pieces are the less chance they have of escaping destruction when the pressure comes upon them. In some way the total wear will depend upon the total area of the pieces forming the mass rather than upon their weight and number, and when these pieces are small the total area of surface they expose runs up in a quite unexpected manner. A cube of 1 inch side exposes a total area of 6 square inches. Cut up this cube into little ones of one hundredth of an inch side—i.e., into pieces the size of fine sand—there will be just the same weight of material, and it will fit just the same bulk of solid space, but the total area of surface will now be 600 square inches instead of 6 inches. If cut up into particles small enough to be classed as fine dust, or mud, the total area exposed by, say, an ounce of material becomes something enormous. Movement under pressure means wear and tear over a large proportion of this great area. For every grain that is crushed there will be many that suffer by having some edges or corners ground away. The idea that this fine stuff is useful for packing and bedding the larger stones may lead to a fallacy. A given stone may be so embedded on and supported by, say, 1,000 or 10,000 very small ones. When the blow comes upon it, that blow has to be passed on to and in some way shared among the thousands of very small ones. The "sharing," however, can only be among those that are arranged (as an electrician would say) in parallel; those that are arranged in "series," or one behind the other, have the same blow passed through the lot. There is no "sharing" in this direction. In a waterbound mass no tension is possible, and one bit cannot help another one alongside it; it can only receive the shock in front and pass it on to the bits behind. It may be so broken in the process that when the shock comes next time it will have to be received and passed on by some other neighbouring bit that had hitherto escaped. Water ensures that this fine stuff is kept on the move, and any readily effective packing or support of some particular stone can only be of service for very few repetitions of the blow.

To Check Destruction

Apparently, what is required to check this destruction is something in the nature of a cement; something which can withstand a positive tension capable of keeping the parts together when any forces tend to separate them. Two well-marked classes of such cements are in use. Of those soluble in water there is the fear that they may dissolve again and be washed out of the mass. Efforts have been made to prevent this by chemical action amongst the constituents of the cement so that the resulting compound is no longer soluble. Of the cements not soluble in water we have the natural bitumens and very many tar products and mixtures. True bitumens are expensive, and their use only becomes practicable by extensive admixture with cheaper materials. All tar products and mixtures suffer from the defect that the various constituents which give them fluidity and are essential to their cementing properly are all somewhat volatile, so that the cement changes with time. This evaporation, however, can be largely controlled, and the valuable properties of the compound preserved for a long time by periodical attention to the surface. All these matters, however, belong to the study of construction, and cannot therefore be properly included in the present paper.

Dyking a Freshly Laid Road

Curing concrete by ponding is a method to be preferred over all others whenever it is applicable. California was the first state to adopt the practice of flooding a finished concrete pavement so as to enable the concrete to acquire strength and hardness under proper conditions in the presence of moisture. It is, of

Curing a concrete road by ponding, showing extra dyke to prevent loss of water.

course, desirable to prevent any unnecessary loss even when water is readily obtained. This is particularly true in hot climates where evaporation is rapid and where scarcity of water often prevails. The method originally adopted in California for preventing unnecessary waste was simply to dyke the road with small earth embankments. The accompanying photograph shows an improvement upon this method, whereby an

additional longitudinal dyke is added near the edge of the concrete. This prevents unnecessary loss of water and gives assurance that concrete will be covered at the crown of the pavement as well as at the sides. This precaution is very essential and the added dyke seems to make this more certain.

Costs of Road Construction

The following figures give the average cost of construction of different classes of roads built in New York State during 1915, according to a report just made public, and will be interesting to compare with analogous costs for pavements constructed in this country.

	Cost per sq. yd. pavement only.	Total cost per mile of highway 16 to 20 ft. wide.
Waterbound macadam	$0.648	$10,250
Bituminous macadam	871	12,970
First-class concrete, 6 ins. thick.	1.121	15,320
Brick pavement on 5-in. concrete foundation	2.015	25,750

To illustrate the types of roads being laid in New York State, the report states that of the 1,073 miles for which contracts were awarded in 1915, 381 miles were of waterbound macadam; 176 miles of waterbound macadam with surface treatment; 347 miles of bituminous macadam, penetration method; 2.2 miles of bituminous macadam, mixed method; 113 miles of cement concrete; 31 miles of brick; and 23 miles of other types. In all new work, wider and more prominently banked curves with greater radii were employed when possible, and provisions taken for increasing the sight range. Depths of pavements have been increased to withstand the pounding of commercial truck traffic, and concrete was more extensively laid, as this seemed to adequately meet motor traffic.

Meetings of the C.S.C.E. for 1916-17

The following is a list of the dates of meetings of the Canadian Society of Civil Engineers, at Montreal for the 1916-17 season. The meetings will be held at 176 Mansfield Street, Montreal:—October 5, monthly meeting; October 19, general section meeting; November 2, monthly meeting; November 16, electrical section meeting; November 30; mechanical section meeting; December 14, monthly meeting; January 4, mining section meeting; January 18, monthly meeting; February 8, general section meeting; February 22, monthly meeting; March 8, electrical section meeting; March 22, mechanical section meeting; April 5, monthly meeting; April 19, mining section meeting.

The subjects of the papers arranged for are very varied, and include some of the most important works now being carried out. The following list must be regarded as provisional, while the titles of the subjects are not definitely settled. Those given below merely indicate the general subject matter of the papers: Dr. J. S. Bates, director, Forest Products Laboratories of Canada, "Forestry"; Mr. E. L. Cousins, chief engineer, Toronto harbour, "Toronto Harbour Works"; Dr. A. Stansfield, McGill University, "Progress in Metallurgy"; Mr. H. G. Hunter, New York Continental Jewell Filtration Company, Montreal, "Progress in Water Filtration"; Mr. T. L. Crossley, Dr. J. T. Donald Laboratory, Montreal, "Asphalt Pavement and Asphalt Testing"; Mr. W. H. Sutherland, assistant engineer, Montreal Water & Power Company, "Montreal Water & Power Company's Reservoir"; Mr. S. P. Brown, chief engineer, Mackenzie, Mann & Co., Ltd., "C. N. R. Tunnel"; Mr. Lesslie Thomson, Dominion Bridge Company, "Transmission Towers"; Mr. J. L. Weller, chief engineer, Welland Canal, "Welland Canal"; Messrs. W. G. Chace and M. V. Sauer, "Construction of Winnipeg Water Works"; Mr. D. H. Nelles, "Ottawa Water Supply"; "Mr. L. M. Jones, city engineer, "Port Arthur Water Works"; Mr. William Storrie, "New Toronto Water Filtration Plant."

Mr. Walter J. Francis is chairman of the committee on meetings; Mr. J. Duchastel, chairman, and Prof. H. M. MacKay, vice-chairman, general section; Mr. J. C. Smith, chairman, and Mr. J. de G. Beaubien, vice-chairman electrical section; Mr. J. M. Robertson, chairman, and Mr. F. B. Brown, vice-chairman, mechanical section; Prof. H. E. T. Haultain, chairman, and Prof. J. B. Porter, vice-chairman, mining section.

Paraffin Wax Coating for Toronto Filter Tanks

Solid paraffin wax is used to coat the wetted interior surfaces of the steel filter tanks and the inside of the pump and filter piping of the new filtration installation just being completed in Toronto. The wax is dissolved in gasoline at a minimum temperature of 110 degrees F. The surfaces to be coated are thoroughly cleaned with wire brushes and must be absolutely dry before applying the paraffin. The coating is put on with whitewash brushes. It was thought that the common tar or asphalt coatings would chip or break away sufficiently to clog the sand collecting and removing system that takes drifting sand from the filter and for this reason paraffin wax was selected.

Railways Cancel Steel Commodity Rates

Canadian railway companies propose to cancel on October 1, 1916, the present iron and steel commodity rates from shipping points in eastern Canada to Atlantic ports for export. Mr. J. E. Walsh, of the Manufacturers' Association, draws attention to the fact that the new rates mean an advance of approximately fifty per cent. Manufacturers in the steel industry are naturally somewhat astonished at this extraordinary increase, especially in view of the very general appeal being made to all manufacturers to develop foreign business, and they are organizing a vigorous attack against these proposed rates.

Large Orders for the Allies

The Standard Underground Cable Company of Canada, Limited, Hamilton, Ont., is at work on a large order of field telephone cable. The extensive use made of electricity on a modern battle field for signalling to, and otherwise communicating with widely scattered bodies of troops, renders electrical conductors a vital factor in the handling of armies, and the frequent destruction and rapid deterioration of such systems of conductors in this service necessitates an enormous and continuous supply. A large order for seamless copper tubes to be used as shrapnel bands has also recently been received. As material of this character is not manufactured anywhere in Canada at the present time, the Standard Company will fill the order with tubes manufactured by its associate company in the United States, which is supplying large quantities of copper, brass and bronze products both direct to the allied governments and indirectly through contractors.

Cutting Sheet Steel Piling

The oxy-acetylene blow pipe has been used most successfully in cutting sheet steel piling and has proved superior to the old methods of sawing. An instance is to hand. Piling, used in the construction of the piers of a bridge, was driven down in sections, each section or sheet consisting of ⅜ in. web, and the thickness on the lock joint was about 2¼ inches. About 860 feet of piling had to be cut off at a uniform height. Despite the fact that at the lock joint practically four sections of metal had to be cut through, between 40 and 50 lineal feet of piling were cut in seven hours, one man handling the job.

Trade Publication

The National Paving Block Manufacturers' Association has recently issued a series of booklets covering various types of vitrified brick roads and embodying specifications relating to their construction. The pamphlets deal with pavements of sand-cement and sub-foundation type, green cement foundation type, and the sand-cushion type. The specifications are very exhaustive and apply to practically every detail in the construction of pavements of this type, including the drainage, grading, curbing, quality of concrete and brick, foundations, etc.

Mainly Constructional

East and West—From Coast to Coast

Western Sandstone Company, Limited, has been incorporated, with a capital of $25,000, head office at Vancouver.

The Humboldt Builders' Supply Company, Limited, has been incorporated, with a capital of $25,000, head office at Humboldt, Sask.

Nearly two hundred excursionists recently took advantage of the opportunity offered by the Welland Canal engineers to view the progress of this work.

In the new contracts to be let on the construction of the Greater Winnipeg Water District the Manitoba Building Trades Council will have representation in drawing up the wage schedules.

The Roman Stone Company, of Weston, Ont., have transferred their stock to the head office in Toronto, having sold their plant in Weston to a United States syndicate, who intend erecting an additional building.

Recent rains have resulted in a swelling of the wood block paving at several points on Regina's streets, resulting in buckling and in some instances breaking. Repairs can, however, be simply effected, it is claimed.

A writ has been issued on behalf of Architect A. E. Nicholson against the Collegiate Institute Board of St. Catharines, Ont., for $8,306, the amount claimed for work done on plans and specifications for a new collegiate.

One of those connected with the work is authority for the statement that two more years will be required to complete the Latter Day Saint's Temple at Cardston, Alta., and that the expenditure will probably reach a million dollars.

Plans for wharves at Vancouver have been drawn up by the C. P. R. The work will cost $1,500,000, and will fit in with the wharf extension proposed by the city at a cost of five million dollars. The C. P. R. will use their wharves for their steamship business, which is of growing importance both on the Pacific and Atlantic coasts.

Mr. G. H. Wilson, secretary of the Ottawa works department, has submitted a report to Commissioner Macallum upon numerous changes that have been made in the management of the various branches since he entered upon his present duties. This report would indicate that the secretary is eliminating all laxity in work coming under his jurisdiction.

A meeting was recently held by the British Columbia Division of the Canadian Society of Civil Engineers, in Vancouver, when the subject of the recent appointment of Professor Swain of Harvard University, as chief engineer of the Railway Commission, with instructions to appoint a staff of engineers to make a valuation and report on the Canadian railways was considered. A resolution was passed instructing the secretary, Mr. D. Creer, to arrange a later meeting of the Vancouver branch to discuss the matter. Mr. R. F. Hayward presided.

The Montreal Builders' Exchange have arranged for a series of fortnightly luncheons at Freeman's Hotel. The first will be held tomorrow, October 5, when Controller Villeneuve will speak on "A Bureau of Municipal Research." Other speakers will include Mr. Ross, of Ross and Macdonald, architects, and Dr. Milton Hersey, who will deal with technical subjects.

The Ontario Highways Department has sent out some 100,000 circulars to farmers in the sixteen counties which have not yet joined in the good roads campaign. The idea which the Deputy Minister of Highways, Mr. W. A. McLean, has in mind, is to educate the farmers so that by the middle of next summer, when the war should be drawing to a close, good roads can be proceeded with throughout the province.

It is reported that the Manitoba Government will receive new tenders for the completion of the parliament buildings at Winnipeg, about December 1. It is also stated that the amended specifications, on which the tenders are to be based, will show a reduction of $1,125,000. This would indicate that the government is not prepared to make an expenditure of much more than $2,000,000, judging from the amount of the James D. McDiarmid Company's tender, received August 21, $3,128,018.61. The saving of cost is to be effected in the finishing and ornamental work.

The Montreal Water & Power Company, under the direction of Mr. J. O. Meadows, engineer and superintendent of the company's water filtration plant, are building plants for making filter alum from bauxite and chlorine gas from brine, which will be placed in operation about November 1. In the manufacture of the filter alum or sulphate of alumina, the process worked out by Mr. C. P. Hoover, chemist and superintendent of the filtration works at Columbus, Ohio, will be employed. Ground bauxite will be obtained, it is understood, from the Aluminum Company of America.

The finding of the coroner's jury at the inquest on the remains of the workmen who lost their lives in the Quebec Bridge disaster is that these men were drowned accidentally while in the employ of the St. Lawrence Bridge Company. The evidence failed to show that carelessness or neglect was apparent in carrying out the operations. One fact which the inquest brought out was the avowed determination of the St. Lawrence Bridge Company, through its president, to erect and place in position the central span of the bridge after the same plans with but a revision of the detail of the universal joint.

Mr. H. A. Gibeau, town engineer of St. Lambert, and Mr. St. Marie, town engineer of Longueuil, P.Q., have been instructed to prepare preliminary plans and estimate for an intercepting sewer for St. Lambert, Longueuil, Montreal South, and Greenfield Park. At the suggestion of the Que-

bec Superior Board of Health a commission representing the four towns has been appointed, with a view of obtaining co-operative action in the matter of sewage disposal, and the result is the proposed construction of an intercepting sewer which will receive all the sewage and discharge it into the St. Lawrence below Longueuil.

Charles E. Ivens, Reeve of the municipality of Wallace, Man., has submitted to Hon. Thomas H. Johnson, Minister of Public Works, a report of the progress made to date in the construction of the provincial highway and main roads in Wallace under the Good Roads Act. It shows that since July, 1913, 123 miles of grades and 50 miles of gravelled roads have been constructed. The total cost of the work done was $156,000. Of this, $78,861 was received from the government, making the net cost to the municipality $77,-138.36. According to the plan laid before the government in November, 1912, a total of 193½ miles was to be constructed.

The committee in charge of the reconstruction of the Parliament Buildings at Ottawa, at a recent meeting with the architects and contractors went over detailed plans of the new building. A few minor changes have been made in the contract conditions and in the interior plans. The committee decided that instead of allowing the contractor an annual rental of 20 per cent. on his plant, as originally intended, the plant would be taken over at present valuation by the Government and then returned to the contractor on the completion of the work at its valuation then. It was further decided to utilize a part of the basement as a library stack-room instead of building a separate stack-room at the foot of the cliff. This will effect a considerable saving.

Following the consideration of reports submitted by Mr. James Bain, chief engineer at the Beach pumping station, Hamilton, Ont., and by Mr. J. Milne, consulting engineer, Toronto, the Hamilton board of control authorized city engineer E. R. Grey and Engineer Bain to prepare plans for new waterworks buildings and equipment, including a high duty triple expansion steam unit and steam turbine. The triple expansion unit was recommended in the reports. Hydro officials are contending in favor of electrically-driven pumps in conjunction with a mountain-top reservoir, and the statement was made that they would submit further plans before any definite action could be taken by the city. The estimated cost of the work outlined by Engineer Bain is in the neighborhood of $300,000.

Commissioner Macallum has prepared a statement of the amount expended on construction works by the city of Ottawa in the last year. The total amount expended by the works and waterworks departments this year was $634,267. In addition to this, $215,004 was expended under local improvement by-laws. Among the large undertakings were the overland pipe, the water main redistribution, the Ottawa South sewer and Billings' and Pretoria Avenue bridges. Other items were fire hydrants and meters, new pumps, water services, and short main extensions. Another civic work was the Bank Street subway on which $14,031 was expended. Local improvements included paving on Rideau, Nepean, Lisgar, Albert and Booth Streets; Rosemount Avenue was widened and $24,215 was spent on concrete walks.

Independent action may be taken by civic officials of Ford, Ont., to provide a system of sewage disposal for the residents, either through the Essex Border Utilities Commission or by the establishment of a separate system for the municipality. Mayor Montreuil would prefer action through the joint commission to establish a system for the five municipalities, but in view of the probability that the plans of the commission may be slow in working out, he and the members of the council are preparing to proceed independently. Plans which are under consideration would mean a probable expenditure of about $20,000 for a disposal plant in addition to the cost of sewers. Action will not be taken until the matter has been taken up with the joint commission. An independent plan undertaken would be carried out with a view to connecting with the joint system, for the municipalities at a later date.

A complete and exhaustive report was recently submitted by city engineer McArthur, of Guelph, Ont., to the city council, dealing with the entire waterworks system of Guelph, as it applies to the source of supply and the carrying of the water by conduit to the city. Investigations made by the engineer showed that there was a very high percentage of loss through leakage, and also that at certain sections the poor condition of the conduit allowed contamination from outside sources. Mr. McArthur recommended alterations and repairs, which, based on preliminary estimates, will cost some $75,000. The largest item of this amount is the replacing of practically the entire main conduit from the lower end of the inverted syphon to the head springs, using wood pipe in place of the vitrified sewer pipe now employed, estimate $46,800. Other items were, developing spring basins, and repairs to reservoirs, including the installation of Venturi meter and recording apparatus.

Personal

Mr. Jos. McBride has been engaged as engineer of the Halton Brick Company, Brampton, Ont.

Major William Ashplant, a former city engineer of London, Ont., has been reported as wounded on the firing line in France.

Mr. W. G. Ross, chairman of the Montreal Harbour Commissioners, has been elected president of the American Association of Port Authorities.

Mr. G. G. Underhill has been appointed Montreal representative of L. G. Monchel & Partners, engineers, with office in the New Birks Building.

Major A. G. Nutter, now in the hospital at Boulogne, severely wounded in the shoulder by gunshot, was formerly the representative of Mussens, Limited, Montreal, at the government terminals in Halifax.

Mr. F. P. Jones, general manager of the Canada Cement Company, recently conducted a party of brokers and financial men over the plant, a good deal of attention being devoted to the new metallurgical branch of the company's plant. From the electric smelter down to the finished product at the freight car door there was every evidence of a well-rounded and smooth working department.

Mr. John L. Lang, of the engineering firm of Lang & Ross, Sault Ste. Marie, Ont., has volunteered for active service and has been appointed captain in the 242nd Battalion now forming at Montreal, a Forestry unit of which Lt.-Col. J. B. White is the officer commanding. Now that both members of the firm have enlisted, Mr. K. G. Ross being with the 227th, the business is in the hands of Mr. G. L. Ramsey, B.A.Sc., D.L.S., O.L.S., who has been associated with the firm for a number of years. Mr. Ramsey also volunteered for service but was rejected as physically unfitted.

Obituary

Mr. George N. Fitt, who was formerly known in Calgary, Alta., as a successful contractor, died recently from an attack of heart failure while hunting in the woods about 18 miles from Sussex, N.B. Mr. Fitt was a resident of St. John, N.B. for the past two years.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Chatham, Ont.
The Water Board are about to construct a water main extension to the sugar factory. Work will include 10 and 12-inch pipe.

The City Council propose to lay a 12-inch sewer on Grey Street by day labor. Chairman of the Board of Works, W. A. Hammond.

Dover Township, Ont.
Tenders will be received until October 7th for the construction of pumping plant for the Dolsen Creek Mechanical Works. Plans and specifications at office of the Township Engineer, W. J. McGeorge, Chatham.

Montreal, Que.
The City Council will construct asphalt and block pavements by day labor. Approximate cost, $250,000. Engineer. P. Mercier.

St. John, N.B.
Tenders on the construction of granite block pavement will be received until 11 a.m., October 9th, by the City Clerk, H. E. Wardroper. Plans and specifications at office of the Road Engineer.

Waterloo Township, Ont.
The Township Council are considering the construction of tile sewers, estimated to cost $3,000: Engineer, Charles Moogh, Cedar and Queen Streets, Waterloo.

CONTRACTS AWARDED.

New Toronto, Ont.
The contract for mechanical filters has been let by the Town Council to the American Water Softener Company, Philadelphia, Pa.

Ottawa, Ont.
The City Council have let the contract for construction of pavement on Parkdale Street to T. G. Brigham, 85 Duke Street.

Pembroke, Ont.
The Town Council have let a contract for construction of storm sewers to H. J. Beatty, William Street, at $10,000.

Sarnia, Ont.
The City Council have awarded the contract for construction of vitrified sewers on Emma and Wellington Streets to Harris & Wales, 219 Collingwood Street.

York Township, Ont.
The Township Council have awarded the following contracts: Asphalt pavement, Constructing and Paving Company, Confederation Life Building, Toronto; concrete sidewalks, Constructing and Paving Company, Toronto; Godson Contracting Company, Manning Chambers, Toronto; Grant Contracting Company, 50 Front Street East, Toronto.

Railroads, Bridges and Wharves

Hamilton, Ont.
The City Council are having plans prepared for a subway under the tracks of the Grand Trunk Railway between Dundurn Park and the bay shore. Approximate cost, $6,000. Engineer, E. R. Gray.

New Brunswick Province.
The St. John and Quebec Railway Company, Fredericton, propose to build a bridge across the Nerepis River, and have submitted plans to the Public Works Department, Ottawa.

Ontario Province.
A vote will be taken on January 1st by the municipalities concerned to authorize the construction of a radial railway between Port Credit and Bridgeburg. Approximate cost, including rolling stock and building, $9,360,000.

Victoria, B.C.
Tenders on the construction of the Rock Ray bridge will be received until noon, October 9th, by the City Clerk, W. J. Dowler. Plans and specifications at office of the Engineer, C. H. Rust.

Wellington Conuty, Ont.
Plans of the proposed bridge are being prepared by Engineer F. McArthur, Guelph, and work will start in the spring. Approximate cost, $35,000.

CONTRACTS AWARDED.

Chatham Township, Ont.
The Township Council have awarded the contract for construction of two steel and concrete bridges to Willliam Stram, Turnerville, at $3,805.

Savage Mills, Que.
The Municipal Council have let the contract for construction of a concrete bridge to C. J. Dryden Company, 1215 Green Avenue, Westmount, Montreal. Approximate cost, $4,650.

Sherbrooke, Que.
In connection with the construction of a concrete dam for the City Council the contract for penstock has been let to Jenckes Machine Company, Ltd., Sherbrooke.

St. Valier, Que.
The Municipal Council have awarded the contract for the construction of a concrete and steel bridge to La Cie Boyer Ltee., St. Valier. A sub-contract will be let for steel work. Approximate cost, $8,000.

Public Buildings, Churches and Schools

CONTRACTS AWARDED.

Dauphin, Man.
The contract for electrical work required in connection with the Court House has been awarded to McDonald & Wilson Electric Company, 309 Fort Street, Winnipeg.

Hamilton, Ont.
In connection with the alterations to Christ Church Cathedral the contract for electrical work has been let to E. A. Wark Electric Company, 8 John Street North.

Kitchener, Ont.
In connection with the church which is being erected for the Polish Roman Catholic Congregation the contract for masonry has been let to Elliott Brothers, Waterloo, Ont., and the carpentry to H. Dunker, 46 Shanley Street, and W. H. Dunker, 58 Louise Street.

Work has been started on the erection of a Sunday school in connection with St. Peter's Church, Queen street. The masonry, carpentry, roofing, and plastering have been let to H. Dunker, 46 Shanley Street; painting and glazing to D. P. Knarr, 97 St. Joseph Street, and heating and plumbing to W. M. Knell & Co., 45 King Street West.

Louisville, Que.
The general contract for the erection of the parish church has been let to J. Coutune, 17 St. Joseph Street, Levis. Steel, stone, and terra cotta construction. Approximate cost, $175,000.

Montreal, Que.
In connection with the church basement which is being constructed for St. Mary's Polish Church, 166 Fulleun Street, the contract for steel has been awarded to the Dominion Bridge Company, 145 St. James Street.

The contract for brick work required in the erection of a church on Iberville Street for the Ruthen Catholic Corporation has been let to M. Marotta, 112 Drolet Street. Other trades will be let by the architect, J. A. Karch, 72 Notre Dame Street East.

Mt. Hamilton, Ont.
In connection with the church now being built for the Union Church congregation the contract for roofing has been let to J. Goatley, 203 Grosvenor Street, and heating to C. Havers, 127 Wentworth Street.

Ottawa, Ont.
The contract for installation of a heating system at St. Luke Hospital has been let to the Garth Company, 28 Craig Street, Montreal. Approximate cost, $8,000.

Sherbrooke, Que.
The contract for the heating required in connection with St. Michael's Cathedral has been let to J. J. Briand, 1277 St. Dominique Street, Montreal.

St. Coeur de Marie, Que.
The general contract for the erection of a presbytery for the parish has been let to J. Harvey, Hebertville Station, and work will start in the spring. Estimated cost, $9,000.

St. John, N.B.
The contract for roofing in connection with the school on Bentley Street has

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Employing Alien Engineers

THE recently issued letter of the Canadian Society of Civil Engineers, expressing their attitude regarding the appointment of a United States engineer to assist the Drayton-Smith-Paish commission in investigating the Canadian railroad situation has called forth a memorandum from the Dominion Government. This memorandum seeks to make apologies for Professor Swain's appointment, pointing out that, having regard to the magnitude and seriousness of the situation which confronts us in connection with our railways, it was essential to procure the very best and most authoritative advice possible. We agree entirely that the proposed investigation is of a character such as to require the best brains the engineering profession possesses, and that in undertaking this very important and arduous task, the hands of the commission should not be tied, nor its powers limited. With all due regard, however, to the government's explanations, we cannot see in what way this rendered necessary the appointment of a foreigner. The government, in taking this course, is deprecating the abilities of Canadian engineers, is indirectly acknowledging the inferiority of our educational institutions and systems and avowing the mediocrity of our engineering societies.

* * *

The commission, we believe, had no thought of laying itself open to such assumptions. National pride and loyalty would naturally prevent it from acknowledging such implications. Yet in this matter the government has put itself into a seemingly anomalous position. They meet the objections to Professor Swain's appointment on the ground that he is a member of the Canadian Society of Civil Engineers. This very fact the government seems to think is sufficient to satisfy the society that their best interests are being served. Yet the absurdity of this argument is all the more clearly shown when at the same time, by going outside the country for an engineer, the government tacitly avows the inability of the Canadian members of that society. Can we co-relate these two viewpoints? Does it not seem incongruous that the government on the one hand should claim to appreciate the worth of the Canadian Society and at the same time sanction the employment of a foreign engineer?

* * *

Sir Henry Drayton is further reported to have made a statement to the effect that all Canadian engineers of sufficient standing to qualify for this position are now, or have been at some time, employed by one or other of the railway companies. Surely this is absolute nonsense. We are confident we should not have to search far to name several Canadian engineers of note, whose ability and impartiality would be beyond dispute and who are not now and never have been associated with any local railway organization.

* * *

It has also been said that the Canadian Society might have chosen a much more objectionable example. We think so, too; but that they did not do so strengthens, rather than the reverse, the stand they have taken in that this case represents the average rather than the extreme. That they could have selected numerous more flagrant violations merely adds force to their objections. Canadian engineers have long been accustomed to consider themselves on a high ethical plane; their professional bodies have been imbued with too much of that so-called professional dignity, and apparently, with an excess of those virtuous qualities of modesty and self-forgetfulness. Is it not time that our engineers stepped down from the heights and got into business for their own interests and those of the public? Should they not combat, determinedly, the pernicious habits of Canadian organizations in constantly procuring outside advice? We fully believe that the principle at stake will commend itself to right-thinking Canadians, and that the action of the Canadian Society of Civil Engineers will justify itself in full measure. It is a matter of congratulation that they have not restrained themselves any longer, but are taking such questions deliberately, to show that they are alive to the situation and appreciate the wide influence and broad connection their societyship confers.

The quantity of tar used in tar dressing roads in Great Britain is estimated to be 160,000 tons, or 35,840,000 gallons on a road mileage of 176,000 miles, compared with 32,000,000 gallons used in the United States on 2,220,000 miles of road

Kent County Highways System

The special committee of the Kent County Council, appointed to prepare a report on a county road system, and members of the council of Chatham, Ont., attended a recent meeting held in that city, at which Deputy Minister W. A. McLean, of the Ontario Highway Department, was present and explained in detail the workings of the Ontario Highway Improvement Act. Mr. McLean made recommendations as to what roads it would be advisable to improve. By following his suggestions every market centre in the county would have one or more good roads into the city. The completed system would mean more than 200 miles of improved roads in the county. The city was urged by Mr. McLean to consider the plan which is being followed in some counties of having the city join with the county in the appointment of a commission which would decide what roads the city would aid in improvement and the distances from the city on the various roads. He also emphasized the great advantage of the use of the split log drag and stated that the Department would pay 20 per cent. of the cost of the work done with this implement on the county roads if the good roads' system is adopted, with 40 per cent. on such culverts and bridges as may be built, and that where there were low places in which a fill was necessary 40 per cent. would be paid when it was shown that this was part of the necessary improvement. The county solicitor was directed to prepare the necessary by-law to be submitted at the December session of the county council providing for the county to adopt the county good roads scheme under the Highway Improvement Act and also designating the roads which would be improved.

Busy Shipyard at Port Mann

Just now, when public attention is largely centred on the vessels under construction at North Vancouver and Victoria for British Columbia's new marine fleet, our readers may be somewhat surprised to learn that at Port Mann, the Fraser River terminal of the Canadian Northern Pacific Railway, in a well-equipped yard, fifty or more ship carpenters have been at work on a number of vessels for several months past. They are needed to round out the company's plans for an up-to-date passenger and freight service between the mainland and Vancouver Island lines, to be initiated in the near future.

At the shipyard two large sealers formerly operating on the Newfoundland and Labrador coasts are being transformed into powerful, up-to-the-minute tugs; one big car ferry is being given the finishing touches as it lies at anchor, and a sister barge is on the stocks and will be ready for launching about six weeks from date. These barges are 160 feet long and 48 feet wide, slightly modelled at the bow, and each will transport eight loaded freight cars. They have a depth of ten feet; the gunwales are built up of 12 x 12-in. timbers, and there are four longitudinal bulkheads of the same size timbers to give the craft sufficient stiffening without the use of hog chains. The deck beams are of 12 x 14-in. timbers set 12 inches apart, and the decking is 5 x 8-in. timber dressed. The bottom is of similar construction to the deck. All timber is clear stock, dressed, and most of it is 48-ft. and 60-ft. long. There is 275,000 feet of lumber in each barge.

The completed ferry slip is located about half a mile above the shipyard. The lower part of the slip is of heavy piling and bulkheading, modelled to the shape of the barges. The apron is operated by hydraulic lift, so that any stage of the tide or river can be met instantly. The slip is also equipped with a three-way switch for connecting with the three tracks laid on the barges.

With the completion of the vessels now on the stocks it is likely the railway company will begin at their yard the construction of an eighteen-car passenger transfer, which will be similar to the one now nearing completion at Quebec, and which will shortly be brought out to operate between Patricia Bay, the Island terminal, and Woodward's Landing, on the mainland. This big transfer cannot be operated with safety beneath Fraser River bridge, according to the opinion of the engineers, and will be kept in the lower river and gulf waters.

New Home for Vancouver Board of Trade

A movement is on foot in Vancouver to secure better quarters for the Board of Trade, which for a number of years has been occupying rather unsuitable and very cramped quarters on one of the floors of the Molson's Bank Building, on the corner of Hastings and Seymour Streets. The matter was discussed at a meeting of the board held Sept. 22, when Mr. G. H. Cottrell expressed the opinion that the present membership of the board and its strong financial backing should make it possible to erect a suitable building on a central site which would contain, in addition to the board's offices, a good central hall and facilities for housing exhibits of the resources of the province. Another member advocated a building wherein the work of all public bodies could be combined and centralized.

Mr. Nichol Thompson, president of the board, said he believed action along the line proposed would have been taken before this but for the fact that the lease of the present premises would not expire for another five years. It might be possible to secure a cancellation on fair terms.

Secretary Blair pointed out that plans were afoot to erect another large ten-storey building in a central location in the near future, and it might be possible to secure quarters therein.

A joint committee, comprising members of the Board of Trade and British Columbia Manufacturers' Association, will look into the matter and report.

Practical Information

Rural contractors specializing in concrete work, especially those building silos and other farm structures, also contractors or others who would like to specialize on such work, will be interested in knowing of a co-operative plan now being carried out by the Extension Division of the Portland Cement Association. Anyone interested in concrete contracting work or in taking up such work is urged to address a letter to the director, Extension Division, Portland Cement Association, 111 West Washington Street, Chicago, for some information that will prove valuable, and that can be obtained without cost or other obligation.

The total production of Portland cement in the United States in 1915, as reported to the United States Geological Survey, was 85,914,907 barrels, valued at $73,886,820. This represents a decrease in quantity of 2.6 per cent., and a decrease in value of nearly 9.7 per cent. The value assigned is computed at a price of 86c. a barrel

Good Country Roads in Ontario

What the Local Government is Doing for the Various Municipalities—Many Counties Taking Advantage of Recent Law

The Department of Public Highways of Ontario, under date Sept. 15, 1916, has issued an appendix to their last annual report, giving general information calculated to interest the counties that have not yet availed themselves of the advantages of recent legislation. These counties will do well to consider that inasmuch as 40 per cent. of the total expenditure is advanced by the Ontario Government out of the general taxation fund, they are, just to this extent, paying for the good roads of other counties, without receiving any return benefits. The report, which is signed by Hon. F. G. Macdiarmid, Minister of Public Works and Highways, follows:

Organization for road improvement is a matter which at the present time should receive much attention, especially in counties which have not already a system of county roads under the Highway Improvement Act. During the period of readjustment at the close of the war, it is important that industrial activity of all kinds be stimulated so as to give employment and prevent the commercial reaction which may otherwise ensue.

At the present time it is the part of patriotism to give every needed support to the men who are so gallantly writing the name of Canada in the annals of the great world conflict. When their courage is rewarded with victory, it will be an equally patriotic duty to show that adequate preparation has been made for peace, and that prosperous conditions await the return of the Canadian overseas forces.

Road-building may be made an important part in this regard, but to that end organization should be carefully considered and created now. County road construction under the Highway Improvement Act is generously subsidized by the Provincial Government, is essentially sound in principle, is not burdensome in cost, and is exceptionally favorable to the minor municipalities. Excellent results are being obtained in the twenty-one counties operating under the act, but it is desirable that the remaining sixteen counties should avail themselves of its advantages.

Counties now having county road systems are: Wentworth, Lanark, Simcoe, Wellington, Lincoln, Oxford, Hastings, Peel, Middlesex, Lennox and Addington, Prince Edward, Halton, Perth, Frontenac, Waterloo, Carleton, Leeds and Grenville, York, Haldimand, Welland, and Essex.

Road improvement under a county road system is a progressive measure which every progressive community can advantageously adopt. The general features of a county road system under the Highway Improvement Act are as follows:

Created by By-law of the County Council.

A county council may, by by-law, assume a system of roads for construction and maintenance. These become county roads, and are under the control of the county council.

Roads of the open country have ordinarily been under the sole control of township councils. Experience in every country which has achieved a system of good roads has shown the necessity of classifying the roads according to traffic, placing each class under separate municipal authority. By this means uniformity of construction is assured and opportunity for permanent maintenance is provided. Roads radiating from towns and shipping points are the basis of a county road system.

A Substantial Provincial Subsidy.

The Provincial Government contributes 40 per cent. of the total expenditure on construction, which is paid to the county annually, after the close of each year's work. It should be made clear that the provincial subsidy is 40 per cent. of the total expenditure; not a percentage of the county contribution. Thus:

The county raises	60 cents
The province contributes	40 cents
The county spends	One dollar

Expressed in another way: For every $1,000 spent by the county the province contributes $600.00, and the county thus has to spend $1,600.00.

The province also contributes 20 per cent. of the total cost of maintenance, estimated on a similar basis.

Mileage of County Roads.

The mileage of roads assumed in a county system is usually from 12 to 18 per cent. of the total road mileage of the county, and therefore bears some proportion to the number of townships and area of the county. The improvement of 15 per cent. of the roads will commonly serve 75 per cent. of the traffic. The average county in Ontario has about 200 miles of county roads.

The roads assumed are usually such as will accommodate the greater part of local market travel, creating a system of main market roads for farm traffic. They are the roads radiating from local market centres and shipping points. They should be connected as far as practicable to serve the needs of through traffic of the locality. These county systems should not be confused with old county roads, many of which have ceased to be the roads of greatest travel.

County Superintendent.

The work is placed in charge of a superintendent appointed by the county council. The superintendent is therefore an officer of the county council, acting in co-operation with the council. He should be an experienced construction man, well qualified to organize and direct labor. The average salary is $1,500 yearly, of which the province contributes 40 per cent., or $600; leaving only $900 as the cost to the county. There is no charge for services of engineers of the Provincial Department of Public Highways, and they are available at all times for consultation and advice.

General Type of Construction.

Construction should be suited to local material and traffic. The standard type is a roadway well drained, graded to a width of 24 feet between ditches, with gravel or stone in the centre 10 feet wide. With very light traffic the metal may have a less width, and for heaviest traffic adjacent to cities may be 18 feet wide.

Under special conditions for roads entering towns or cities a stronger type of construction may be permitted by the department.

Cost Per Mile Varies.

The roads commonly built under county road systems are not necessarily expensive. They are usually gravel roads, or broken stone roads, well graded and drained—such as serve the needs of farm traffic. Preferably material of the locality, gravel or broken stone, is used. If there is no local material, and it has to be brought in by rail, the cost is greater—but is shared by the province.

A number of districts in Ontario, such as portions of York, Peel, Halton, and Welland, have no local material for road-making. In such cases an entirely new road must be built, often on a clap subsoil, and freight rates on stone must be added—all tending to higher cost, and amounting to from $4,000 to $8,000 per mile.

In other districts, such as Frontenac, Lanark, or Leeds and Grenville, there is an abundant supply of stone on or close to the road, and frequently the task is one of regrading and putting a surface over an old stone or macadam road. In such cases a cost of $2,500 or $3,500 per mile is an ordinary expenditure.

Certain districts, on the other hand, have an abundant supply of gravel. Many of the roads have been gravelled from time to time and a good foundation has been made. In such cases the work usually consists of removing sod shoulders, improving the drainage, and adding a new surface of gravel—costing from $1,000 to $2,000 per mile for substantial work suited to local traffic.

Equalizing Expenditure Among Municipalities.

County councils frequently desire to make the expenditure in each township proportionate to its equalized assessment, and on such a scale that there may be spent in each township an amount equal to what the township has contributed, plus the provincial grant. The act will permit a county to adopt this adjustment of expenditure if so desired.

Towns and Villages Are Aided.

The county council may by by-law make grants to towns and villages not separated from the county for the improvement of extensions or connecting links of county roads in such towns and villages, and certain of such grants may be included in the statement of annual expenditure. Grants are commonly proportionate to what the town or village has paid in the county rate, plus the provincial subsidy. Grants eligible for a provincial subsidy are those made to villages having a population of 1,500 or less, and those made to municipalities with a population of over 1,500 and less than 3,000, provided the improvement is carried out on streets passing farm or sparsely occupied property. Streets may in cases be assumed as county roads if so desired.

The Annual Cost Is Not Burdensome.

Road-building is necessarily a slow process. Ten or fifteen years is commonly required to complete a county road system. The work should therefore be financed on an annual basis, and may be carried on, if desired, without debenture issues. The total cost in a term of years should not deter counties from undertaking construction if the annual cost is not burdensome.

An annual rate of one mill, or one and one-half mills on the county assessment, would enable most counties in the province to finance construction. This may be supplemented by a small debenture issue to meet the cost of bridges, special grading, or other permanent work. The following schedule is merely suggestive, and indicates how this might apply in the case of counties which have not adopted the system:

County.	Suggested mileage of county roads.	Amount annually produced by county road rate of 1½ mills.	Suggested annual debenture issue	Total raised by the county annually, 60 per cent.	Provincial subsidy, 40 per cent.	Total annual expenditure available.
Brant	100	$19,500	$10,500	$30,000	$20,000	$50,000
Bruce	330	42,000	.....	42,000	28,000	70,000
Dufferin	140	16,500	7,500	24,000	16,000	40,000
Dundas, Stormont, and Glengarry	322	37,500	7,500	45,000	30,000	75,000
Elgin	230	33,000	9,000	42,000	28,000	70,000
Grey	415	48,000	.....	48,000	32,000	80,000
Huron	330	60,000	.....	60,000	40,000	100,000
Kent	285	40,500	4,500	45,000	30,000	75,000
Lambton	285	37,500	7,500	45,000	30,000	75,000
Norfolk	180	22,500	7,500	30,000	20,000	50,000
Northumberland and Durham	375	42,000	.....	42,000	28,000	70,000
Ontario	240	34,500	7,500	42,000	28,000	70,000
Peterboro	140	13,500	10,500	34,000	16,000	50,000
Prescott & Russell	190	24,750	5,250	30,000	20,000	50,000
Renfrew	125	24,000	6,000	30,000	20,000	50,000
Victoria	166	21,000	9,000	30,000	20,000	50,000

Explanation of Schedule.

Column 1 gives the name of each county of the province which has not a system of county roads.

Column 2 suggests a suitable road mileage for a county system.

Column 3 gives the amount which would be raised annually on the county assessment by a special county road rate of 1½ mills. A rate of one mill would in many cases give a very sound basis of finance.

Column 4 suggests a sum to be contributed annually from a debenture issue, to supplement the amount produced by the special road rate.

Column 5 is the sum of the amounts in columns 3 and 4, and represents the total to be raised by the county annually by a special rate and small issue of debentures.

Column 6 is the amount of provincial subsidy earned by the county contribution given in column 5.

Column 7 gives the sum of the amounts in columns 5 and 6, and shows the total amount available for expenditure annually for county roads.

Thus in the case of Brant, 100 miles is suggested as a reasonable county road system. A county rate of 1½ mills would produce $19,500 annually. This might be supplemented from a debenture issue to the extent of $10,500, making a total county contribution of $30,000. Adding the proportionate provincial subsidy for construction ($20,000), the county would be able to spend $50,000 annually.

Statute Labor Along County Roads.

Statute labor along the county roads belongs to the township councils. This labor may be worked out on the side roads, or may be wholly commuted. On a county system of 200 miles this would commonly amount to 10,000 days, having a commutable value of not less than $10,000. Devoted to township roads, it materially aids in raising the general standard of roads in the county.

A New Burden Is Not Created.

The county road expenditure is by no means an added burden. No new roads are created. The roads are essentially those which are now most heavily travelled, and therefore require a considerable township expenditure for maintenance in their present state.

Bridges and culverts on them must be built in any event; the statute labor is a considerable offset to a county appropriation.

Machinery.

The machinery required varies with the type of road built and material used. If no local stone is available stone-crushing plants will not be necessary. At times it is profitable to put pit gravel through a crusher and screen. A county is required to have at least one steam roller costing $2,800. The average county has gradually invested about $20,000 in machinery and plant. Of this the province pays 40 per cent. A judicious expenditure on machinery is one of the most profitable that can be made, as proper equipment will reduce the total cost of the work, and will produce better and more durable results. When not in use on county roads the machinery may be loaned to towns, villages, and townships wishing to carry on special construction.

Special Conditions.

The act is sufficiently flexible to meet special conditions on an equitable basis. Cities may co-operate with county councils in the improvement of roads adjacent to the city, under the suburban road sections of the Ontario Highways Act. Toll roads may be purchased and incorporated in the county road system. Townships may be omitted from the system so as not to retard the county as a whole. Further information may be obtained by communicating with the Department of Public Highways, Parliament Buildings, Toronto.

New Westminster Harbor Developments

The Dominion Government is Expending Large Sums of Money in Creating a Great Fresh Water Port at the Mouth of the Fraser River

PORT authorities and harbor boards the world over are to-day devising or directing great enterprises having for their object the improvement of existing harbors or the creation of new ones, in order to keep pace with the ever-growing requirements of modern shipbuilding and trade expansion. The city of New Westminster, located on the mighty Fraser, has the good fortune to be served by a harbor commission the members of which appear to be fully alive to the importance of their great port being on fresh water—a fact which alone is sufficient to commend it to mariners because it means a clean ship's bottom, without the expense of docking and scraping.

It was long ago recognized that the only drawback to the port's usefulness was the somewhat difficult navigation from the mouths of the Fraser to New Westminster, due to the frequent formation of shifting sandbanks and mudflats under the action of the swift tidal currents. The problem involved in the "training" of the river by means of revetment works and mattress barricades in 1912 engaged the serious attention of the late George A. Keefer, then District Engineer of Public Works at New Westminster. When convinced of the feasibility of the plan, after a most thorough inspection of the river channels, he succeeded in interesting the department at Ottawa, and Mr. Le Baron, an engineer of great experience in levee and jetty construction on the Mississippi River, was commissioned to visit New Westminster and report on the scheme. Mr. Le Baron confirmed Mr. Keefer's findings, and thereupon he was retained by the city to prepare a plan of the proposed work, which was adopted and proceeded with the by the Dominion Government.

Work on the North Arm Jetty.

For more than two years past very extensive operations have been in progress at the main channel or southern mouth of the Fraser River, and also at the entrance to the North Arm—a narrow branch of the river, which is used by log-towing tugs and other small vessels when making the trip from Vancouver to Fraser River points, or vice versa, owing to the saving in distance over the main channel route. Work on the North Arm jetty, 22,300 feet in length, was commenced by the Marsh, Hutton, Powers Company, of Port Arthur, Ont., in May, 1914, and the contract was completed in September of last year, at a cost of over $850,000. The channel provided is 300 ft. wide and 10 ft. deep at low water, and extends through the sandheads to the Gulf of Georgia. The sand removed from the channel by the hydraulic dredges was deposited over the jetty to form a bank on the south, or exposed, side. In style of construction the work is similar to that being carried out on the main channel. The single bulkhead, extending a distance of 21,000 feet, is built as follows:

A row of fir piles is driven at least 10 feet into the ground at a distance of 8 feet apart, centre to centre,

A mattress being constructed of brush and bound with wire.

and capped with a 8-inch x 8-inch timber and fastened to each pile with a ¾-inch drift bolt 22 inches long; all joints in the caps come on top of a pile, and at each joint a piece of timber or splice block 3 in. x 8 in., 4 ft. long, is spiked on to the cap on the opposite side to the sheet-piling with eight 7-inch spikes. The top of the cap is 14 feet above low water.

On the south, or exposed, side of the row of piles a row of sheet piling has been driven close together and not less than 4 feet into the ground. This sheet piling is 3-inch x 12-inch fir, fastened to the cap with two 7-inch spikes. A batten of 1½ inch x 6 inch is driven at at least one foot into the ground opposite each joint in the sheet piling; this extends to the top, and is fastened to the piling with 4-inch spikes on each edge of the batten and one foot apart from top to bottom.

When necessary the piles were flatted to enable the sheet piling to be nailed to the cap and kept in perfect alignment.

How the Mattresses Are Constructed.

On each side of the bulkhead, brush mattresses about two feet thick were laid, the width of mattress on each side being three times the height of the bulkhead from the ground to the top of cap. The mattresses were built of brush three inches in diameter and under, laid as closely as possible and comprising three layers, the top and bottom layers laid parallel to

Mattress in place alongside the bulkhead about to receive stone.

the bulkhead and the middle layer at right angles, and tied with double wires (No. 6 galvanized telegraph) every five feet each way, each mattress being similarly tied to its fellow. From the end of the bulkhead, for a distance of 1,300 feet outward, the jetty is formed of tiers of mattresses; the bottom mattress is 90 feet long, 45 feet on each side of the jetty, and not less than 2 feet thick. The second tier is about 4 feet thick, not less than 50 feet long, 25 feet on each side of the centre line, and each succeeding layer is 4 feet thick and reduced in length 10 feet, 5 feet on each side of centre, the top layer being not less than 20 feet wide. Rough quarried rock was used for weighting each mattress when towed into position, the proportion being one ton for every 20 square feet. Extra rock was placed on each side of the sheet piling on bulkhead, being piled to within a foot of top of cap, the slope on south side being 1½ to 1. The top and slopes of the section of mattress jetty extending seaward from the bulkhead is covered with large rock to a depth of at least three feet, the top being brought to the same elevation as the top of cap on bulkhead (14 feet above low water).

The average height of the North Arm jetty is four feet above high water level. It is, of course, laid out in shallow water, away from the channel, to ensure a firm foundation. The effect is to guide the waters as they flow out of the river and prevent them spreading over the low sandheads. Following the completion of the work the harbor commission controlling the North Arm carried out extensive dredging operations.

Operations on Main Channel of River.

The South Arm of the Fraser is the main or ship channel from the Gulf to New Westminster. It has always been navigable by the largest freighters, but careful pilotage has been necessary. The Le Baron plan provides for extensive revetment works on both sides of the channel. At present there is a jetty under construction on the north side at the mouth, which comprises three units. No. 1, about 7,000 feet in length, outward from Steveston, was completed by Broley and Martin Contracting Company, New Westminster, several years ago, at a cost of $250,000; the second unit of 7,000 feet was let to Marsh, Hutton, Powers Company, but was not proceeded with until the North Arm unit was completed last fall, when the company's plant in use there was shifted to the new contract, which was executed in record time, at a cost of about $400,000. The same concern was then authorized to proceed with the third and final unit of the jetty, which will complete the protective system on the north side of the main channel reaching from Steveston across the sandheads to deep water. This section will be about 9,500 feet in length, and will cost between $500,000 and $600,000. Work was started early in the present year, but as only a small amount of the estimated cost had been voted by the Dominion Government the operations are on the point of being blocked unless another appropriation be soon made. In an effort to interest members of the Federal Cabinet in the urgency of continuing the work without further delay New Westminster City Council, Board of Trade, and Harbor Commission extended invitations to Sir George Foster, Hon. Martin Burrell, and Hon. Dr. Reid—all of whom were on the Coast recently—to make a trip of inspection down the river. The latter was able to accept, and on Sept. 26th visited the works, accompanied by a large party, the snagboat Samson being utilized for the occasion. The necessity for the speedy completion of the third unit in order that a start might be made on the south side jetties was fully explained to the minister, who was able to see for himself the great work to be accomplished by carrying out the Le Baron plan in its entirety. Running out from either shore at an angle, and about half a mile apart at the narrowest point, the jetties will confine the main

Bulkhead and batten construction, with continuous mattress ready for sinking.

channel of the river and direct such a volume of water into the ship channel that it will automatically be kept free from sand and silt and thus permit of the present depth of about 24 feet being increased to 30 feet by dredging, as planned by the Harbor Commission. It was pointed out to the minister that the city of New Westminster has already expended almost half a million dollars in harbor and dock work on the strength of the promise made by the Dominion Government that the Le Baron plans for river improvement would be carried out so that the largest ships visiting the Coast might be able to take advantage of the facilities offered by the great fresh water port on the Fraser. It

is satisfactory to know that Hon. Dr. Reid promised to bring the matter of the jetty work improvement before his colleagues immediately upon his return to the capital.

Brush and Stone in Vast Quantities.

From an economic standpoint the work being carried out by the Marsh, Hutton, Powers Company during the past two years has been of great benefit to a large section of the population in the district adjoining Vancouver. During the early months of the war, when there was a good deal of depression, as many as 700 men were employed at times, at good wages. Farmers and fishermen along the Fraser and Pitt Rivers for a distance of 60 miles were busy cutting brush and loading it on scows. So far over 50,000 cords of brush, or 1,000 scow loads, have gone into the jetty mattresses, all of which has been purchased from settlers along the two rivers. The mills have supplied large quantities of lumber, over $45,000 worth being required for one unit. Local quarries have also benefited greatly in the supply of over 280,000 tons of rock. To convey this material to the men at work on the jetties the company has had to keep six tugs and about forty scows in commission. Work has gone on all the year round, the only interruption being due to adverse weather conditions at the mouth of the river at times.

The work on jetty construction has been carried on under the superintendence of C. C. Worsfield, district engineer of public works for the Dominion, and W. P. Gross, assistant engineer in charge of work, their offices being in the Government Building, New Westminster.

The contract for the dredging operations in connection with jetty construction was awarded to the Pacific Dredging Company, Ltd., and by them was sublet to Marsh, Hutton, Powers Company, Ltd., who have carried it out in a satisfactory manner. A vast amount of material has been moved, the cost of the North Arm work alone being over $300,000.

Suspension Bridge for Carrying Water Pipe to Supply the Citizens of Fernie

In June of this year the water in the Elk River at Fernie, B.C., rose 9 ft. above low-water mark, and as a result the wooden bridge which was built in 1908 to carry the 12-inch main supplying the city of Fernie with water was washed out, carrying about 200 feet of the pipe line with it. A meeting of citizens was held, and the city engineer, Mr. William Ramsay, C.E., Mem. Inst. Mun. Eng., was instructed to throw a cable across the stream, on which to carry the pipe, as the building of another wooden structure was out of the question at the moment owing to the height of the flood water. The illustration shows very clearly the method adopted.

On either side of the stream a tower was built of tamarac logs, hauled from the bush, and near the top of each tower was placed a 3-inch steel shaft, with two loose sheaves to carry the top cables, 1-inch diameter crucible cast steel, each with a breaking strain of 30 tons. Two more 1-inch steel cables were stretched across the stream at the level of the pipe line, and on these were laid the 2-inch x 12-inch x 20-foot planks to form a platform on which to lay the pipes. After the cables were tightened sufficiently, wrought iron drops were placed at intervals of about 10 feet, connecting the upper and lower cables, and on each of the drops a turnbuckle was fixed so that adjustment could be made at any time.

The pipes used on the work were 12-inch diameter 9/16-inch steel, in lengths varying from 18 ft. to 20 ft., and the joints were leaded and caulked. Close to one of the towers a slip-collar expansion joint was installed to take care of the expansion and contraction due to changes in climatic conditions.

Six weeks after the washing out of the wooden bridge the cable structure was completed and the water turned on to the city, and up to the present time the line has worked without a hitch, not one of the lead joints having leaked to any extent under a working pressure of 100 pounds per square inch.

After the water had been turned on it was thought advisable to brace the towers and at the same time a 1¼-inch cable was run across the top of both towers back to the anchors on either side, for the purpose of picking up the slack in the centre of the span.

The total weight of the structure between towers is 16 tons. The span from tower to tower is 290 feet,

Method of carrying a pipe across a river by suspending from towers.

and the pipe line is now at such a level that high water cannot interfere with it in the future.

The towers are set in concrete to a depth of 8 ft. and braced to concrete anchors behind, while guy lines of 5/8-inch cable were placed at intervals of 84 ft. on the bridge and run back to anchors on each bank, in order to keep the bridge steady in heavy windstorms.

The cable and fittings were supplied by the Western Equipment and Supply Company, Calgary, while the steel pipes were of the Matheson joint type, and were supplied by the General Supplies, Ltd., also of Calgary.

The work was carried out by day labor, under Mr. Robert Kerr, a local contractor, to whom great credit is due for the success of the work.

The total cost was about $3,000.

Tenders for the new C.P.R. jetty pier at Vancouver were closed Sept. 25th, and are now being considered by the engineering department. It is understood that nearly a dozen British Columbia firms submitted offers on the structure.

Construction of Brick Pavements

Requires Proper Drainage—Concrete Foundations Best—Necessity for Expansion Joints—Higher Cost Justified

BRICK is generally conceded to make an ideal pavement when carefully constructed and the best of materials employed. There are several types of road construction that can be used, the adaptability of each being governed to a large extent by a number of variable conditions, including the limitation of funds, availability and cost of material, soil conditions, geographical location, as well as the character and amount of present and possible future traffic. Actual experience has demonstrated that if the work is carefully performed, brick roadways are unsurpassed in affording rigid surfaces having good traction qualities, in sanitary conditions and freedom from dust and in durability. An objection is that under horse-drawn traffic they are rather noisy, especially if grout-filled. For placing or repairing service pipes they are readily opened, and repairs to the road are easily made.

Provided the highest standards of skill and workmanship are employed there is probably no road surpassing those made of brick. In constructing this road, specifications must be carefully and implicitly followed and care taken to see that none of the multitude of details is subordinated.

The National Paving Brick Manufacturers' Association publish specifications covering various types of brick roads, which govern the operations and qualities of materials, and which, if followed, will unquestionably produce the highest quality work. In the matter which follows, items appearing in these specifications governing brick road construction are adapted and enlarged upon:

Proper Drainage Required.

The one vital requirement in any road, be it dirt or brick, essential to long life is proper and efficient drainage, both surface and under-drainage. Adequate under-drainage should be provided to remove rapidly all water from the subgrade of the roadway to a depth of not less than 18 inches below the base of the pavement.

The function of surface and under-drainage in road construction is that of stabilizing subgrade conditions by making it dry. The property of soil to sustain loads is dependent upon its character and its degree of density, which should be uniform. The presence of water in the subgrade seriously vitiates the development of the full capacity of the soil as a load-bearing element.

The engineer should examine carefully the proposed location of the pavement, noting all evidences of underground flow or seepage, and if the effects therefrom will come within the limit of 18 inches below the base of the pavement, he should prepare special plans and specifications to insure a rapid removal of the water in accordance with the provisions of this section.

Pavements are subjected to the wear and tear of traffic and to the destructive forces of nature. Thorough drainage, minimizing the danger of injury from the latter source, aids the pavement in resisting the former, and an initial expenditure for thorough drainage is justified in keeping with the hazards that await unless this feature is thoroughly cared for by preventive measures.

The necessity for proper foundation drainage is seen when cracks and sunken spots or other defects are observed in highways, which are unquestionably due, in the first instance, to ineffectual drainage. While it is probably true that longitudinal cracks sometimes result from causes other than defective drainage, a well-constructed foundation, properly drained, is a sure preventive of sunken spots, and cracks are most unlikely to develop. A well-drained and well-constructed grouted brick pavement is impervious to surface water. A splendid example of this is shown in the brick boulevard from Buffalo to Niagara Falls, which was submerged by a flood for a period of two or three weeks and yet came through absolutely unharmed.

In grading, the subgrade should be thoroughly compacted by rolling and depressions being filled in and rolling repeated.

Concrete Foundations.

The foundations are usually of concrete. Under some conditions macadam or No. 2 vitrified brick may be used, but economical instances of their use are rare. In the concrete foundation the material should be carefully graded and mixed. It is impossible to write definite specifications for mixing concrete, particularly to fix its proper consistency. At present the best evidence for determining the proper consistency is found in the nature of the green concrete in place. Certain facts, however, are definitely established.

With any given proportion of the aggregates to cement, the strongest concrete is obtained when the aggregates are uniformly distributed to form a homogeneous mass, coupled with the presence of sufficient water thoroughly admixed, to hydrate the cement, withal producing a concrete readily handled and placed without the necessity of tamping.

These requirements prohibit the use of an excess of water, which reduces the adhesion of the cement to the fine aggregate, and in turn of the mortar to the coarse aggregate, and which furthermore produces a porous concrete upon the evaporation of the water simultaneous with the hardening of the concrete.

On the other hand, a lack of water is prohibited by the requirements of sufficient water to hydrate the cement, ease of handling and placing, and freedom from tamping.

In individual instances the proper amount of water to be used in mixing depends upon the nature of the aggregates, their relative dampness when they enter the mixer, and the use to be made of the concrete. Thorough dry mixing of the ingredients is essential as well as thorough mixing after the water has been admitted.

Strict supervision of all the operations and factors involved, coupled with the exercise of sound judgment, are essential in securing the best results in mixing and placing concrete.

Broken Stone or Slag Foundation.

In making a broken stone or slag foundation it is advisable to grade the material, the sizes being designated as indicated in this table:

Minimum.	Maximum.	Designations.
Dust	¼ inch	Screenings
¼ inch	1½ inch	No. 1
1½ inch	2½ inch	No. 2

Upon the subgrade a layer of No. 2 stone or slag is

laid and rolled, and upon this bottom course is spread a layer of No. 1, followed by a binder of screenings or sand to a depth of not more than ½ inch, each course being individually rolled and compacted.

Compliance with these specifications for broken stone and gravel foundations insures a foundation of the highest grade for these types, and the association recommends that these methods be followed wherever possible.

There exists, however, the contingency that insufficient funds are available to construct a broken stone, slag, or gravel foundation by the method specified. In such cases recourse may be had to a one-course foundation using run of crusher stone or slag in place of the graded sizes. Again, there may be local stone or gravel deposits available for foundations in localities where the facilities for crushing and screening are meagre and the quality of the stone or gravel inferior to that specified for the two-course and binder method.

Foundations may be laid with such material with entire success and satisfactory degree of economy provided very special attention is paid to secure thorough subsoil and surface drainage. Such foundations may be laid in one course with stone or slag, crushed or broken in such sizes that none are larger than two inches in the maximum dimension. Precautions should be taken, however, to guard against the presence of an excess of dirt or vegetable matter in the stone or gravel.

Old Streets as Roadbeds.

Concrete, old macadam, or gravel streets are sometimes surfaced with brick, and in such a case may be regarded as foundations. Streets that have been built heretofore of concrete, macadam, or gravel, which, by reason of their existing condition it is deemed economical to place thereon a brick wearing surface, in some cases at least the grade and cross-section lines of the completed brick street or road will be such that what remains of these old streets can be utilized as a portion of the foundation for the brick-wearing surface without any further disturbance of the same, and they do not have to be scarified, but sufficient like material added thereto to bring them to a true grade and cross-section is the most economical procedure in such cases.

Natural Earth Foundation.

For constructing brick pavements upon a natural earth foundation the finished surface of the subgrade shall be considered as the foundation. The specifications may then be followed by omitting the items on artificial foundations.

Many brick pavements have been successfully constructed upon natural earth foundations. Close attention and care are required in regard to drainage and workmanship. In localities where soil conditions afford an easy natural drainage and where practice has secured careful attention to the details of construction, particularly the grouting, extraordinary results have been accomplished. Even in soils necessitating extra expenditure and care to maintain a dry subgrade to a point below the frost line, economical and satisfactory pavements are built. Every precaution should be taken to secure thoroughness, both in respect to the preparation of the grout and to its application. Every joint should be thoroughly filled to the bottom with uniformly mixed grout.

Such construction is particularly applicable and economical on residential streets bearing a light volume of traffic, and if the contingencies mentioned obtain and are adequately met, durable and satisfactory pavement construction results.

Immediately before placing the concrete for the foundation a prepared longitudinal expansion cushion should be placed against each curb, with the ends closely joined. It should be in lengths convenient for handling, and having a depth equal to the thickness of the concrete and that of the brick, so that when the pavement is finished the upper edge of the cushion will be flush and even with the brick surface. The prepared expansion cushion should be composed of such combinations of asphalt or other bituminous material with inert aggregate that it will remain pliable throughout the range of temperature to which it will be exposed.

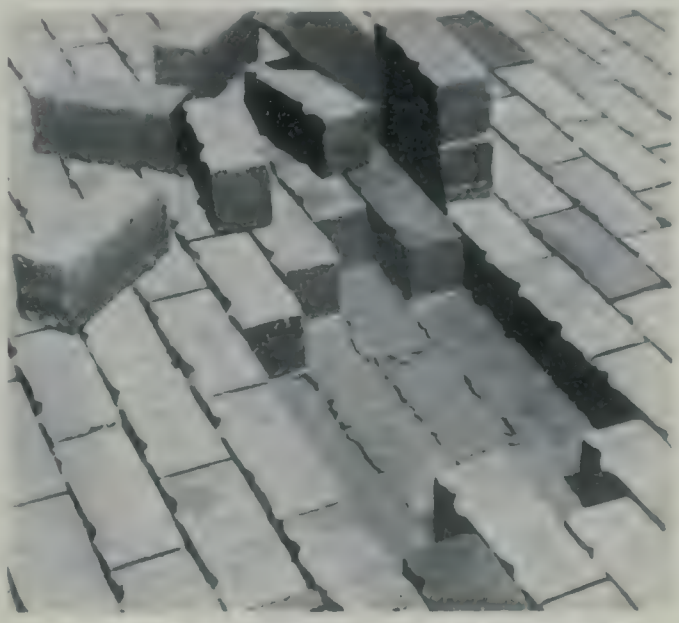
It should be of thicknesses namely:

Width of roadway.	Thickness of Expansion cushion.
Less than 20 feet	⅜ inch
20 to 30 feet	½ inch
More than 30 feet	¾ inch

The use of transverse joints in the surface or base of the roadway is not deemed advisable.

Super-foundations.

For a superfoundation a sand cushion has been commonly employed, which affords a means of bedding the brick so that the upper surfaces will conform to



Monolithic brick pavement—appearance of the foundation after the brick surface has been rolled.

the pavement surface and serves as a means of taking out any unevenness in the foundation. It is not in most cases advisable to use a sand cushion exceeding 1 in. in thickness.

Within the last few years a new type of superfoundation has been developed called the sand-cement type, which consists of applying to the foundation already prepared a mortar composed of one part of cement to four parts of sand, stone screenings, or granulated slag, which when thoroughly rolled and compacted should not be more than one inch in depth. When the brick are laid and rolled, the pavement is sprinkled lightly, and the water penetrates the cushion in sufficient quantities to cause the cushion to set.

On the superfoundation the bricks are carefully laid with the better faces uppermost and the lugs all in the same direction, care being taken to insure even rows and proper curb joints.

Another type of brick road of recent origin is the monolithic form or green concrete foundation type. This road is constructed by laying the brick-wearing

surface directly on a freshly-placed concrete base and rolling the bricks to bed them in the concrete before it takes a set. After the subgrade is prepared concrete is laid to the required depth and coated with a thin layer of sand and cement in the proportion of one part cement to three parts sand. In striking off the surface a special template is employed, which consists of a 6-inch steel I-beam in front and a 6-inch steel channel, or I-beam, to the rear, held in a rigid frame with the two members parallel, spaced two feet from centre to centre, and shaped to conform to the cross-section of the roadway. The rear member is held in the frame with the bottom 3/16-in. higher than that of the front member. Rollers are attached to the frame, which rest, when in use, upon the guide rails.

In shaping the concrete deposited from the mixer it is thoroughly spaded, settled, and roughly surfaced immediately ahead of the double template. A sufficient amount of dry mixture for the thin coating is supplied continually between the framed templates to that in the forward movement the rear template distributes the necessary film over the entire surface, producing the required smoothness.

By reason of the fact that the rear cutting edge of the double template is three-sixteenths of an inch higher than the front cutting edge the forward movement of the template, as described, performs two operations simultaneously, namely, that of striking off the concrete which has been deposited upon the subgrade and spreading over its surface the three-sixteenths of an inch film of the dry mixture, which, being of equal quality of the mortar in the concrete, becomes an integral part of the concrete.

This method, so easily adapted to the construction of brick country roadways wherein fewer conditions militate against the use of steel side forms, so readily placed to perform the functions indicated, will be found equally adaptable for use in building city streets.

Concrete of a consistency which will sustain the brick surface uniformly during the laying, rolling, and filling the joints is a necessary prerequisite. It is equally necessary, too, that the green concrete shall be of a consistency affording a mortar surface which will insure a perfect adhesion of the brick.

Upon this green concrete foundation, laid as described, the bricks are immediately laid and rolled. The use of transverse joints in the surface or base of the roadway should not be permitted.

Grout Filling.

After the bricks are set in place a grout filler is used to unite the surface into a monolithic layer, and so ensure that the wear on the bricks is no more than that of friction and grinding. The recommended grout mixture consists of 1 part of cement to 1½ parts of sand, mixed dry in a mechanical batch mixer until the mass attains a uniform shade. The dry batch is mixed with sufficient water to produce a thin cream in a specially devised grout box. The filler is applied to the joints and the surplus swept in.

After the first application of the filler has been made and sufficient time has elapsed to allow it to settle in the joints without reaching its initial hardening, a second application is mixed and spread in the manner provided for the first, with the exception that less water is used in mixing, producing a filler of somewhat thicker consistency. The filler is swept immediately into the joints until they are completely filled by means of squeegees having rubber edges.

Successive applications of the filler are made as provided until the joints remain completely filled, flush with the surface of the roadway.

After inspection of the roadway and sufficient time has elapsed to avoid injury to the filler, a protective covering of sand or earth not less than 1 in. in depth should be spread upon the roadway and kept moist for a period of not less than four days. The roadway should not be opened for traffic for 15 days.

Type of Joint.

It might be pointed out that the method of finishing the grouting of a brick pavement may differ with the type of brick used. With round-edged bricks no excess grout must be allowed to remain on the surface, otherwise the pounding of traffic breaks it and pulls out portions of the grout in the joints, exposing the edges of the bricks. With square-edged bricks, on the other hand, the grout in the joint is protected, and there is no danger from a heavy surface coating.

The above paragraphs give a resume of the general features to be observed in the construction of brick roadways without expressing any great detail. There are good roads and bad ones employing paving brick, but there is ample proof that a perfect brick highway can be laid and that it will be unimpaired under traffic conditions for years. In Canada this type has not yet found extensive use, especially in the rural localities, but there are certain merits attached to it, in spite of high cost, that it is well for roadway engineers to give it serious consideration.

Enterprising Firm of Contractors

The Marsh, Hutton, Powers Company, Ltd., has its head office in the Westminster Trust Block, New Westminster, and is preparing to enter the general contracting field whenever normal business conditions are resumed. The resident directors are V. L. Marsh, H. J. Powers, and C. A. Bourne, the first two formerly of Port Arthur, Ont., where their company has carried out over $3,000,000 worth of construction, including some of the largest apartment and business blocks in that city, also the Dominion customs building and other public works. Mr. Marsh is president and Mr. Bourne vice-president of the company. Three or four subsidiary lines of business and industry are promoted by this enterprising firm. They are the controlling factor in the British Columbia Transport Company, Ltd., which has a fleet of tugs and barges on the Fraser, with docks and bunkers for building material at New Westminster. All the crude oil used in New Westminster and on the Fraser is imported by the firm. They have built tank storage at New Westminster to handle the business.

Just now the company is completing a large shingle mill in the city of New Westminster for the Dominion Shingle and Cedar Company, Ltd., which is another of their subsidiary companies. The owners are making a capital investment of $75,000 in this new shingle plant and in logging equipment to get out the raw material. They expect to have the plant in constant operation very shortly.

Another Wire-Cut-Lug Brick Maker

The John Kline Brick Company, Wickliffe, O., is the newest and the thirty-fourth member of the Dunn Wire-Cut-Lug Brick Company's family of licensees. This plant has a daily capacity of 40,000. It is a progressive company that makes a high quality of brick which has stood the test of service. Mr. J. C. Kline is president of the company.

British Industrial Organization for War

SECOND only to the bravery and determination of the soldiers in the field, the one factor that has contributed to the recent successes of Britain's forces in France has been the bravery and determination of those who, under the severest difficulties and privations, it may be, are laboring to keep the army supplied with munitions. The cry from the battle line has always been for shells, and yet more shells, and in England there are thousands and thousands of workers—men and women—who are taking up the response to this cry, by doing their "bit" in the great ordnance factories and arsenals.

It is well known how unprepared Great Britain was at the beginning of hostilities, how unable she was to keep her small but staunch army supplied with munitions. Yet since that time she has built up an organization that has never been equalled in the history of the world, an organization which in two years has so outdone the work of Germany's forty that at last it may be said that the British army has enough shells and to spare, that her gun power is so superior that it can blast a way through the strongest fortifications military engineering can devise, which with two years' preparation might be considered as nearly impregnable as anything could possibly be. This organization seems all the more wonderful, when it is realized that this is but a drop in the bucket, that it is only a portion of a far greater undertaking whereby Britain has had to organize, equip and train an army of millions, maintain her navy, finance her expenditures and those of her allies, organize her defences and withal, to provide equipment for armies other than her own. It has been a truly stupendous task and frought with awful difficulties. That numerous mistakes and errors of judgment were made cannot be denied, but the work done by the Ministry of Munitions has reached a very high order of efficiency in overcoming these perplexities. Very little idea can be grasped of the magnitude of the undertaking, the more so when it is considered that the industry was entirely new and was developed without any guiding precedent. The thousands of workers had to be trained to perform the exacting and skilled operations and those unacquainted with the operation of machines required special teaching. As production increased, too, unsuspected troubles developed, and the original difficulties multiplied.

Our English contemporary, the Engineer, presents in a recent issue an account of the difficulties that have been and are being overcome, describing graphically what large production has meant. The article points out the value of industrial organization of the British Empire for war, how it has accomplished wonders and indicates how such an organization is of incalculable benefit to trade after the war by increasing the knowledge of what the country can produce and what are its capabilities. In the following paragraphs are extracted portions of this article:

Growth of Organization for War

For all practical purposes there was no British industrial organization for war in August, 1914, and little more even in June, 1915. It is still far from complete at the present time, but the development since the end of last year has undoubtedly gone sufficiently far, and with sufficient rapidity, to achieve the necessary end. More, however, still remains to be done, and important portions of our national factories still require to be brought up to their maximum output. It must never be overlooked that the Ministry of Munitions does not control material supplied to the Royal Navy, nor that approximately half the engineering resources of this country are still solely engaged on work for the Admiralty. All requirements had to be met as far as possible on the basis of relative urgency of demand, and for the first twelve months of the war the Navy absorbed by far the greater portion of our resources for the manufacture of big guns. The first call was for shell and cartridge cases. Shops and machinery for the production of both were required; the former took time to erect, and the latter as long to manufacture. Shells are not as easy to make as they may appear to be from the drawing, particularly as they have to conform to extremely strict Admiralty or War-office conditions and specifications—and especially to the former—while as regards the latter Department any shell maker can produce ample evidence of the difficulties he has experienced in meeting War-office inspection.

Taking first of all the question of output of shell, there were perhaps only six or eight firms in the country that had experience of shell manufacture before the war, and the quantities then ordered were very small. The rapid extension of facilities—factories of all natures and industries of all kinds being pressed into service—resulted in a comprehensive upheaval in the engineering industry, and revealed a rapidly increasing succession of unexpected problems. The difficulties, in consequence, of attaining a well co-ordinated balance of production, so that, for example, shell should be turned out complete, and not, as was sometimes inevitable, the bodies kept waiting for fuses or both kept waiting for lack of filling facilities, were enormous. The ramifications into which the shell industry entered were very great indeed, and consequently in many cases the production was held up in an apparent cul de sac, until some particular branch could be speeded up into line with the rest. Before the war there were only three national factories working for the Army; now there are ninety-five. That fact in itself is remarkable, but it gives no proper indication of the great increase of output on the part of the individual worker, nor of the greatly improved methods of production that have been introduced in the last two years. Few if any of the original shell or cartridge-drawing shops could have been described as model factories compared with those which have been erected in the last twelve or eighteen months. When it is considered that our pre-war output was only supposed to be sufficient for an Army of about 200,000 men, whereas we have now to supply nearly twenty times that number, who are using shell at a rate never previously contemplated in spite of the eye-opening experience of the Russo-Japanese war, it will perhaps be more readily understood what was the problem which the Ministry of Munitions was called upon to solve.

The earliest difficulty undoubtedly lay in the fact

that the Navy required to be supplied first. The next, and perhaps the greatest difficulty of all, was to meet the continual change of conditions on land. There is little doubt that our reserves of guns and ammunition for both services were lamentably inadequate before the war, but at the present time, if we take gun and howitzer ammunition for the land service, we are now manufacturing and issuing every week to France about as much as the whole pre-war stock in the country. To give some indication of the more detailed difficulties which had to be overcome in increasing, say, the 18-pounder production 170 times over and above what it was two years ago, we may instance the question of taps and gauges. For tapping the 2-in. fuse hole in the nose of the shell special taps are required, having about fourteen threads to the inch. A good tap will last for perhaps two hundred shells, often less. Consequently for a works producing perhaps 100,000 18-pounder high-explosive shell per week, no less than 500 taps are required per week. In the course of manufacture many get distorted in the hardening process; others are made with insufficient accuracy to secure the perfect thread required; some inevitably get damaged and others give out long before their proper quota is accomplished. In other words, the tool department of a works capable of producing this quantity of shell must be in a position to make at least 700 to 800 taps per week in order that there shall be no delay on this particular operation. Such a quantity is so abnormal that it is hardly surprising that the need for items of this nature or for the tool makers to produce them, was not foreseen before the war.

The Supply of Gauges

The question of supply of gauges for gauging shell is one of the greatest difficulties which the Ministry encountered. The average type of shell requires 30 gauges, a percussion fuse 100, and a time fuse 240. Taking the latter to mean plus and minus gauges, we get for a week's output of 100,000 time fuses the amazing figure of 24,000,000 gauging operations per week! If the week be taken as 120 working hours we have 200,000 operations per hour! Unless these gauges are absolutely accurate—and the only means of maintaining accuracy, for they are apt to wear under the intense rate of production and inspection required, is frequently to supply new sets—abnormal inconvenience is caused through differences of dimensions occurring, in fuse work particularly. Frequent difficulties have arisen on this score owing to slight differences, due either to wear or manufacture, between the shop gauges and those of the inspecting staff. The difficulty of obtaining men capable of making accurate gauges in the quantities that have been required was a very serious, and unforeseen, one. The lack of gauges led inevitably to the continued use of worn gauges, with a resulting confusion that occasioned extremely inconvenient situations at a later date.

These two items alone will serve to illustrate the type of unsuspected troubles that developed with increased intensity of production. The labor difficulty that arose is too well known to require comment. While instances of minor difficulties, tremendously important as they intrinsically proved to be, were certainly among those that it was hard to foresee, some of the major troubles might certainly have been anticipated, and met by a much greater peace-time effort towards industrial organization in the event of war. The commandeering of the motor trade en bloc and its subdivision into different sections for motor transport vehicles, shells or aeroplane engines was an obvious and easily accomplished step which entailed few difficulties. The question of steel production, however, was a matter of much greater difficulty, for the simple reason that shell steel is of a special nature and the quantities required were far away greater than could possibly be supplied by the pre-war manufacturers. Gun steel and shell steel differ considerably in their constituents, and further, to complicate matters still more, a very large portion of the Admiralty shell steel differs considerably from that of the Army shell steel, which again differs in composition for various types. The commercial steel producing firms had to be roped in to supply the special steel required, and no little difficulty was at first experienced in obtaining the quality required, particularly in the case of high carbon steels. In the case of the smaller shell, particularly the 18-pounder high explosive, which are made from rolled bar steel, great difficulty was experienced by many firms new to the work in avoiding "rokes" or longitudinal cracking in the finished bar. All these firms had to be arranged and sub-divided so that the whole output of certain furnaces went to one firm, and that of others to another works, the labor involved in making such arrangements being of a highly complex order. Machine tool builders were promptly brought into line, and set to work on shell lathes, various makers being practically allocated to various firms. Special tools for shell work, generally of the simplest type—one operation per machine being by far the best method of manufacturing shell, even though the handling involved is greater—had to be provided by the thousand, and in spite of the heavy construction many will be scrapped before the end of the war. Textile firms, the previous output of which was mainly of looms and carding machines, came forward, and, working in conjunction with one or other of the large armament companies, accomplished wonders in the manufacture of shell and hand grenades.

What Has Been Accomplished

It is generally supposed that in Germany before the war it was customary for the Government to place small orders for shell with a number of engineering firms throughout the country, so that on the outbreak of war shell manufacture would not be an absolute novelty to the contractors as it has been in so many cases in England. German munition supply as regards shell was also considerably facilitated by the inferior quality, as regards composition of the steel or detailed design of projectile, that would be accepted compared to our own standards, and, on the other hand, our own was hampered to no small extent by the abnormal number of different types of shell required, the Admiralty in this respect being very exacting. It is, however, very hard to imagine that German organization, about which in many cases the grossest exaggeration has existed equals, let alone excels, that which the Ministry has built up for munitions production in this country, albeit the Ministry has had only about fifteen months' experience as compared with Germany's years of preparation. Locomotive and railway carriage builders are making gun mountings and gun-carriages for large howitzers; bridge builders are making air-ship sheds; one very eminent firm of feed pump manufacturers is making both shell and aeroplanes; in other cases, well-known builders of ordinary merchant steamers are building both aeroplanes and torpedo-boat destroyers; a firm of sewing machine specialists is making shell and fuses, and another, the pre-

war business of which was shop fittings, is building seaplanes. Instances could be multiplied a thousand-fold. With a good organization and decent shops, a little common sense and adaptability, experience has shown that this industrial expansion for war purposes could be achieved with far less difficulty than might have been imagined two years ago. It might be said, moreover, to have been attained with remarkably little organization except as regards the supply of labor, and this disorganization is now less a present difficulty than a prospective source of trouble. Women may or may not be, as was once propounded, the source of all evil, but introduction by the tens of thousands into what were, if quite fallaciously, previously regarded as skilled trades may lead to a very considerable quantity of it at the end of the war.

Effect of Present Organization After the War

There is certainly one very deep and far-reaching effect which the present war organization of British industries will have on the peace organization after the war. Intimate as have been the relationships between the individuals composing groups of manufacturers, as, for instance, in the case of the textile trades, the motor trade, or the armament firms, the groups themselves were generally very detached. Inter-exchange even between the groups was never so close or wholehearted before the war as it is to-day, and it is only reasonable to suppose that this influence will have a markedly beneficial effect after the war. The enforced close association of firms, the interests of which were poles apart before August, 1914, and the principals of which were frequently unknown to one another even by name, together with the fact that such a large number of firms have had to undertake work that they never would have contemplated before the war, has opened the eyes of all concerned to their own capabilities of production. Three years ago many manufacturers would have utterly repudiated the idea that their plants were suitable for such a widely different class of work from that which they are now compelled to undertake, one particular reason naturally being the financial one. Once the fear of serious loss was removed by the virtual guarantee of reimbursement against it—and this can be said without any disparagement of the patriotic manner in which both plant and services of staff were volunteered from the very beginning—work was undertaken of a nature that has been of a thoroughly educational kind. It has broken down reserve, and destroyed opposition to progress and extension when it was really perceived how simply the change could be wrought; it showed manufacturers in all branches of trade that many unexpected things could be accomplished if they would only attempt them. In a word, the industrial organization of the country for war, by adding enormously to our knowledge of what we can produce and generally expanding the knowledge of manufacturers as to their own and other people's capabilities, has probably brought about a state of affairs that will be of incalculable benefit to the engineering trade after the war.

Chart for Determining Strength of Wooden Boards or Beams

The accompanying chart determines by graphic methods the strengths of wooden boards or beams, or, vice versa, determines the size of a beam to withstand a given load. The operation of the chart can be seen by studying a particular example, say, to find the safe strength of a white oak beam 2 in. wide by 4 in. deep and 5 ft. between supports. From column B, the maximum allowable stress for white oak is 1,000 pounds per square inch. The safe stresses of several other common woods are indicated in column B, or are tabulated in the table below. The length given is 5 ft., or 60 inches, which is indicated on column A. Join this point to the point 1,000 already determined on B, and produce the line to meet the line C. Join the point representing the width 2 in. on column D to the point representing the depth 4 in. on column G. Join the point of intersection with column F to the intersection previously found in column C. The required solution is found in column E. In this instance the beam will hold a little over 700 pounds uniformly distributed, or 140 pounds per foot of length.

The process may be reversed to find the size of

Handy chart for finding strength of wooden beams.

beam necessary to bear a given load. The table below gives the safe strengths of the principal woods, based on a safety factor of ten:

	Pounds per sq. in.
Ash	1,100
Beech	1,150
Cedar	1,000
Chestnut	1,000
Douglas fir	1,200
Elm	1,300
Hemlock	800
Hickory	1,20
Locust	2,000
Long leaf pine	1,300
Maple	1,000
Norway pine	800
Spruce	900
Tamarac	900
Walnut, black	900
Western hemlock	1,100
White oak	1,000
White pine	900
Yellow pine	1,100

The Building of Fireproof Houses

Do Contractors and Architects Sufficiently Urge the Necessity of Lessening Fire Risk?—Work that Doesn't Show on the Outside

THE question of fire protection is a most important problem in connection with almost any type of building. Dwellings are usually the least protected of any class of buildings, and when of flimsy, improper construction, constitute an unnecessary hazard. To safeguard homes against damage and loss by fire knowledge of proper design and reliable information as to the selection of building materials are essential. Wood in most cases is condemned as providing a fire hazard, but this material can be safely and economically employed if careful construction is used and the danger from fire not disregarded.

Universally wood is found in all dwellings, and they will continue to be built in this way in the indefinite future. Wood is the least expensive, most universally available, and the most adaptable material, and at the same time responds to architectural treatment in such a way as to appeal to the sense of beauty and sentiment. With intelligent selection of lumber, a consideration of the strength and careful workmanship, dwelling construction is materially safeguarded. The introduction of proper stops or fire-barriers forms a protective measure of prime importance, and yet the efficacy of such provisions is rarely known or recognized. The introduction of these precautions would go far to reduce the enormous fire losses occasioned in dwelling houses. From an economic point of view, also, such a measure gives valuable returns. The cost of proper construction in relation to the fire hazard adds only a small percentage to the total cost of the house and yet produces returns in lower insurance rates and greater safety far in excess of the additional expense.

The National Lumber Manufacturers' Association have recently issued a pamphlet dealing with this subject and incorporating some suggestions of the National Board of Fire Underwriters in regard to the necessity of fire-stopping and the methods of installing suitable protective devices of this nature. In the following paragraphs are extracted some of the more essential suggestions and requirements:

The Necessity for Fire-Stopping.

No one feature of house construction will contribute more to its safety in case of fire than efficient, well-placed fire-stops. Their purpose is to delay the spread of fire, and so assist in confining it to the story in which it starts. This protects life, and affords a better chance of extinguishing the fire.

Fire-stops are principally applicable to non-fireproof buildings, such as frame houses or those with incombustible walls but with the interior construction of wood, though they should be used in any type of building where openings exist which would act as flues to distribute heated air or gases from a fire in one part of a building to other portions where they might ignite combustible material. The added cost of such protection is very slight, and yet its value is so little appreciated the ordinary dwelling either has no fire-stopping at all or else the work is so indifferently done as to be practically worthless. Because such work does not show when a building is completed, and because its importance is usually entirely underestimated it is often carelessly installed, with the result that the fire-stop is so in name only, it being merely a delusive imitation, which, if called upon to fulfill its purpose, fails completely.

The danger resulting from careless workmanship is greater in the construction of wooden fire-stops than when incombustible material is used, because care is not often taken to properly fill the spaces and keep the joints tight. Loose joints, even though the openings be very small, will allow the passage of the heated gases. It must be understood that air or gases heated to the point of ignition of wood—less than 1,000 degrees F.—even though they carry no flame and are invisible, will set fire instantly to practically everything combustible with which they come in contact.

Suitable Materials.

Incombustible fire-stopping materials should be employed when possible, since they are unburnable and the possibility of fire getting by them is considerable decreased. Moreover, such materials as mineral wool, concrete, or mortar, are soft when used, and can be more or less tamped or pressed into the space prepared for them so as to preserve tight joints preventing the passage of heated air or gases.

There is a variety of materials which make excellent fire-stopping, such as brick-work, stone or cinder concrete, gypsum block, mineral wool, or any incombustible material which, when packed into a space, will form a united mass that will not fall out through holes that might be made in the woodwork supporting it. Strips of metal lath can often be advantageously used to hold mortar or plaster until it sets. Some of these materials are nearly always found as waste products about a new building; their use involves no expense except for labor, and the disposal of refuse is an advantage.

When fire-stopping is made of brickwork, almost any sort of bricks will serve the purpose, such as second-hand, underburned, chipped, broken, or other defectives, providing sufficient mortar be used to fill all joints and interstices.

Concrete or mortar fill for fire-stopping can be made from any refuse from plaster, masonry, or concrete work. Even if such material has set, it can often be broken up, and by adding sufficient fine material to fill voids, enough cement or lime to produce a set, and water sufficient to form a plastic mass, it will make a very satisfactory fire-stopping material. Cinder concrete is also good.

Mineral wool is a superior material for fire-stopping. It is especially adapted for places where it is necessary for the stopping to yield as the timbers shrink; also in places where its light weight is advantageous.

Solid gypsum blocks are excellent for fire-stopping in dry locations. They can be purchased the correct size to fit between studs, or ordinary partition blocks can easily be sawed to fit any space. It is important that any loose joints in such material should be filled with mortar. Such blocks will also yield when wood shrinks and throws pressure upon them. Gypsum products absorb moisture freely, and when wet they lose considerable of their strength, and should not be used, therefore, in contact with wet surfaces or where likely to become water-soaked. They are also liable to deter-

iorate when subjected to temperatures in excess of 200 degrees Fahr. for considerable periods of time, and they should not be used where such unusual temperatures prevail.

Asbestos mill board, gypsum plaster board, or metal lath and plaster are useful fire-stopping materials where considerable areas must be covered, such as a cellar ceiling or as the lining of the pocket for a sliding door. They are not recommended for the ordinary stopping of walls or partitions.

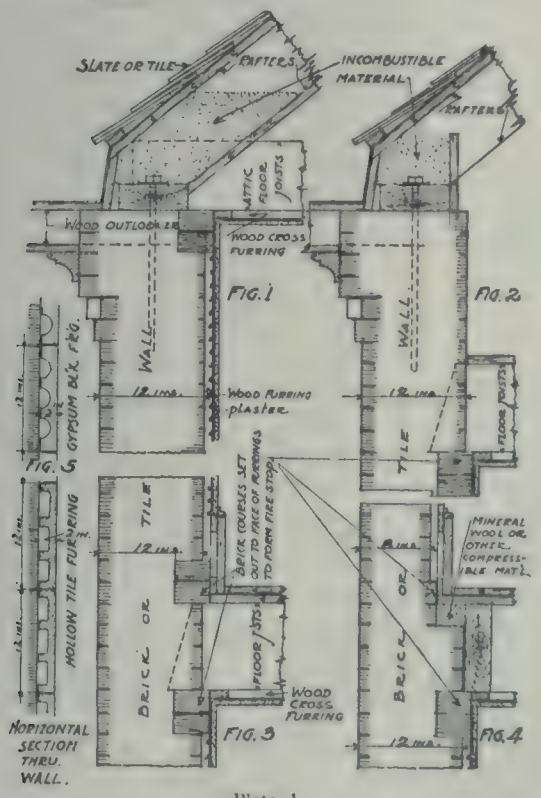


Plate 1

Dwellings with Walls of Brick or Other Masonry

Fig. 1. Method of fire-stopping at eaves when attic floor joists are level with plate.

Fig. 2. Same as Fig. 1, except that attic floor joists are any distance below the plate and built into the wall. Support for fire-stopping might be same as in Fig. 1 if more convenient.

Fig. 3. In this and the other figures of this plate note fire-stopping of wooden furring by two courses of brickwork being set out to face of furring above and below floor joists all around the building. Other types of masonry walls should be built out in the same manner.

Fig. 4.—Fire-stopping at a floor level when the wall is thinner above the floor than below.

Fig. 5. Terra cotta and gypsum block wall furring.

Construction of Fire-Stopping.

Fire-stopping shall be arranged to cut off all concealed draft openings and form an effectual horizontal fire barrier between stories. Open passages in frame walls or partitions are a prolific cause for rapid spread of fire to all parts of a structure. If fire occurs in the cellar or basement they act as flues to carry it to the attic. If the fire starts in the attic the sparks fall down the hollow spaces. Results are disastrous in either case.

For all walls furred with wood the masonry between the ends of wooden beams should project the thickness of the furring beyond the inner face of the wall for the full depth of the beams; or a double course of bricks or other masonry above and below the beams should project beyond the face of the wall the full thickness of the furring (Plate 1). Such fire-stopping in hollow block walls is usually obtained by using 1-inch slabs of the same material, the slabs serving also as the bearing course for the floor joists. Where floor beams are parallel to a wall furred with wood, there should be a space of not less than 2½ inches between such wall and the nearest beam. This space should be filled in solidly with brickwork or concrete for the full depth of the floor beams, or be equivalently fire-stopped. Two courses of brick, slabs, or other masonry are required to cut off a furring space, for mortar joints may drop out of a single course and render it useless.

Incombustible furring is excellent, since it entirely prevents a fire creeping along a wall from one storey to another behind the plaster. Terra cotta or gypsum furring blocks or tile are much used, and are quite satisfactory. They have a series of grooves in the back face, which affords the necessary air space between the wall and the plaster (Plate 1, Figs. 4 and 5). There are also several styles of metal furring strips, to which metal lath is attached, and so serve the same purpose. Where walls are likely to be damp, terra cotta furring would probably be most satisfactory. All these forms of furring should be firestopped with mortar a few inches at the bottom to prevent possibility of their acting as flues for heated gases and bringing them in contact with wooden construction in the floor above.

Where walls are studded-off, the space between the inside face of the wall and the studding at the floor level should be fire-stopped with incombustible material. The beams directly over the studded-off space should be deadened with not less than 4 inches of incombustible material, which should be laid on boards cut in between the beams; or, better still, use 4-inch solid gypsum plaster blocks cut to fit the space between the beams and supported by cleats, thus avoiding the board supports. The under side of such beams should be protected by a covering of metal lath or plaster

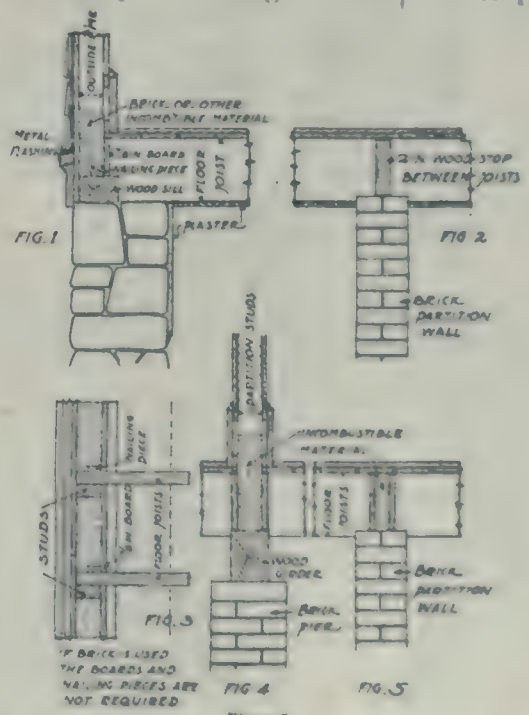


Plate 2

Figs. 1 and 3.—Elevation and plan showing fire-stopping of wall of frame building at line of [illegible] between studs and floor joists.

Fig. 2.—Fire-stopping with timber cut between floor joists on top of brick partition.

Fig. 4.—Fire-stopping of partition resting on wooden girder.

Fig. 5.—Same as Fig. 2 except that incombustible compressible material between two boards is used instead of a timber.

board, and plastered to a total thickness of [illegible]-inch, or a double layer of [illegible]-inch asbestos mill board with broken joints.

In frame buildings which are to be lathed and plastered or otherwise sheathed on the inside, all stud walls

should be completely fire-stopped with brickwork or other suitable incombustible material at each floor level. The spaces between the studs should be filled to a height of 4 inches above the floor level (Plates 2 and 3).

Partitions.

Where stud partitions rest directly over each other and cross wooden floor beams at any angle they should run down between the floor beams and rest on the top plate of the partition below, and should have the spaces between the studding filled in solid to at least 4 inches above each floor level with approved incombustible materials.

Methods for fire-stopping various forms of partition construction are shown in Plates 2 and 4. While incombustible material only is recommended for fire-stopping, it may not always be practical to require it; therefore, in some cases the sketches indicate methods

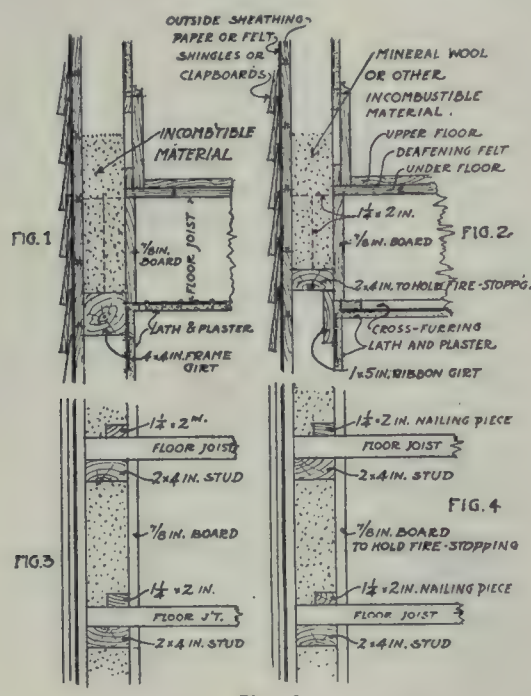


Plate 3

Figs. 1 and 3. Elevation and plan showing fire-stopping in frame wall at connection of upper floor joists with girt.
Figs. 2 and 4. Fire-stopping at same place for "Balloon frame."

for placing both incombustible and wooden fire-stopping, but incombustible material should be used wherever suitable.

There are some places in wooden construction, such as a fire-stop along the top of a brick partition over which a floor is laid in the storey above (see Plate 2, Figs. 2 and 5), where wooden fire-stopping, or a compressible incombustible material, such as mineral wool, must be used, otherwise the shrinkage of the timber construction will in time cause the floor to bulge. A course of brickwork resting on the foundation wall and built between the ends of joists is a method of fire-stopping frequently recommended as an addition to a wall stop such as shown in Plate 2, Figs. 1 and 3. Such brickwork, if built snugly against the underside of the floor, as it should be, is likely to deform the floor when the timber shrinks. If the wall stopping is effectively done with incombustible material it is doubtful whether such secondary stop is necessary.

If the location is dry, and an additional fire-stop is desired, gypsum partition block would serve the purpose well, or it may be made of asbestos board, or metal lath and plaster might be used. A wooden board could be used, but is not so good as incombustible material. Such a stop in an existing building in which the timber had practically ceased to shrink could be constructed of brickwork without objection.

Roofs.

Dwellings within 10 feet of other non-fireproof buildings shall have the walls behind eaves or cornices fully fire-stopped to prevent fire from a nearby building breaking through into the attic space. Such fire-stopping will also protect against fire which might lap up under the eaves through the windows from a fire within. The most vulnerable point of attack for an exposure fire of this kind is under the eaves, for the heat banks up there and the woodwork is always highly combustible, since never exposed to storms. With ordinary construction numerous cracks are almost certain to exist alongside the rafters communicating directly with the attic space. It is therefore important that the space above the plate and between the rafters be filled as tight as possible. Where masonry walls are used they should extend up to the under-side of the roof boards or be fire-stopped as indicated.

Combustible cornices are always troublesome in case of fire. They catch fire easily, are usually dry, and so burn freely, and a fire travels through them rapidly. Incombustible cornices are safest. Even though the framework be of wood, it is wise to cover the exterior surface with incombustible material where practical. Metal lath and cement plaster or stucco could be used on flat surfaces on under-side of cornices.

When sliding doors are pocketed in partitions such pockets should be completely fire-stopped at sides, top and bottom. Asbestos mill board or plaster board is suited to this use.

The surface of the walls or partitions behind wooden wainscoting and dados shall be plastered flush with the grounds and down to the floor line. The same stopping shall be placed behind all applied wooden trim, such as fancy wooden paneling.

The space between stair carriages shall be fire-stopped by a header beam at top and bottom. Where a stair run is not all in one room, or where a closet is located beneath the stairs, the stair carriages should have an intermediate fire-stop, so located as to cut off communication between portions of the stairs in different rooms or between the closet and the room in which it is placed. Such stops can best be made of plank.

If a flight of stairs is so arranged as to be the only construction separating two storeys at a place where they are located, as, for example, between the cellar and the storey above, the under-side of the stairs should be covered with metal lath or ½-inch plaster board and plastered to a total thickness of ¾ inch.

Pipes and Ducts.

Care must be taken that all spaces surrounding pipe, speaking-tubes, and so on, are fire-stopped at each floor with incombustible material, so as to form tight joints. If necessary, close-fitting metal caps should be provided at points where pipes pass through floors, ceilings, or partitions. Steam and hot water pipes must be kept away from all woodwork, which should be sufficiently protected against charring.

Hot Air Pipes and Registers.

Where a furnace hot air pipe passes through a floor, the space between the pipe and floor construction should be filled with incombustible material, like mineral wool, supported by sheet metal or metal lath. The space between a register box set in a floor and the casing protecting the floor construction should also be

fire-stopped. This protection is important, since the spaces around hot air pipes and register boxes form easy passageways for fire. There is also a danger from the furnace becoming intensely hot, and, as a protective measure, both the furnace and pipes should be covered with very thick asbestos or equivalent material. The simple thin asbestos paper is insufficient.

Horizontal Cut-Offs for Cellars.

The best possible cut-off is a fireproof floor. Such floors are quite applicable to dwellings. They should be used wherever possible, for they constitute a distinct safeguard. Such floors may be constructed of steel I-beams, with stone or cinder concrete, terra cotta, or other approved fireproofing between them, with suitable protection for the bottom of the beams; or steel beams may be omitted and the floor be constructed entirely of reinforced concrete, or a composite construction of reinforced concrete beams filled between with hollow tile, or metal or plaster forms with a concrete covering may be employed. A concrete

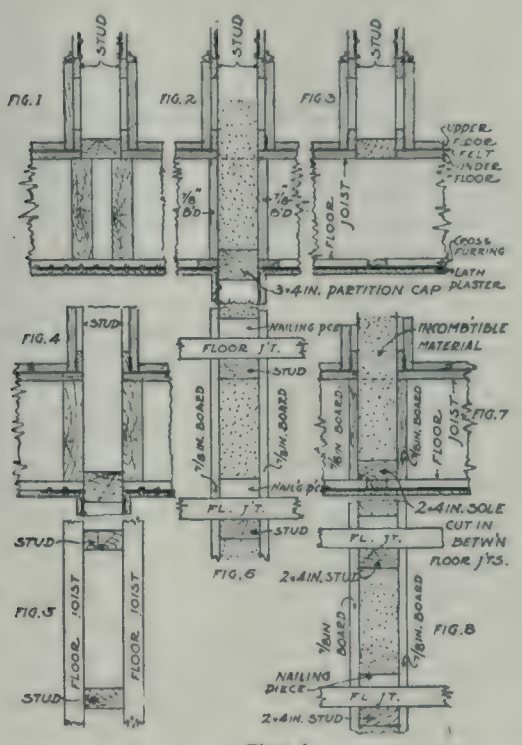


Plate 4

Fig. 1. Interior partition running same direction as floor joists supported on double joists, fire-stopped at bottom by 2 x 4 inch sole.

Figs. 2 and 6. Elevation and plan of partition footing on 3 x 4 inch cap of partition below running crosswise to joists, showing method of fire-stopping between joists.

Fig. 3. Partition running crosswise to floor joists footing on sole used as a fire-stop. This would be improved by addition of some incombustible material on top of sole.

Figs. 4 and 5. Elevation and plan of partition running same direction as floor joist footing on 3 x 4 inch cap of partition below used as fire-stop, and floor joist placed alongside studs.

Figs. 7 and 8.—Elevation and plan of partition running crosswise to joists footing on sole fitted between joists at bottom and fire-stopped with mineral wool between two boards. Brickwork or other solid incombustible material could be used.

floor construction can be very simply installed in houses, with steel or wooden beam supports to reduce the span and thickness.

Reliable building constructors state that such concrete floors can be built in most localities at practically the same price as first-class wooden construction. Owing to the fact that the fireproof floor is also waterproof, vermin-proof, and thoroughly rigid, it would justify increased cost. If desired, a wooden finish flooring may be laid over the concrete. The supporting beams under the floor, whether steel or wood, must be protected, the former by 2 inches of fireproofing and the latter by at least ½ inch of metal lath and plaster, plaster board, or ¼ inch asbestos mill board.

In ordinary dwellings where it may be impossible to secure the high degree of protection afforded by a fireproof floor for a cellar cut-off, or dwellings of a grade which would not warrant the expense of such a floor, it is still very essential that efficient temporary protection be provided, and that every precaution be taken to prevent a cellar fire spreading to floors above, at least long enough to afford reasonable time to subdue it. This can be accomplished by protecting all communicating openings, as elsewhere provided, and by covering the ceiling with fire-resistive material.

Although it would not be practicable to fire-stop an existing house as completely as here recommended for new construction, nevertheless it would be quite feasible to apply several of the suggestions to any existing house in which such barriers had been omitted, and would materially lessen the fire risk. The great obstacle in securing efficient fire-stops in a building is in getting architects and builders to realize the supreme importance of such precautions. The ordinary carpenter or builder has an inherent prejudice against doing work which does not visibly advance his contract. Ignorant of the serious annual life and property loss due to fires in combustible dwellings, he considers the possibility of such a fire too remote to worry about, and the general experience is that he will not put in proper fire-stops unless very carefully watched. Someone must be responsible for rigid inspection to insure that such work is conscientiously performed.

Earnings of Edmonton's Utilities

Below is a statement showing the earnings of the utilities of the city of Edmonton for the seven months ending July 31, 1916:

	Surplus on operation.	Surplus on all charges (including depreciation and capital charges	
Telephone Department . . .	$ 98,267.21	$ 6,710.64	
Electric Light Department . .	85,174.34	37,342.36	
Waterworks Department . . .	103,525.00	14,625.00	
*Power House (to June 30).	109,968.93	38,930.05	
Street Railway Department.	85,859.55	63,010.78	deficit
Total	$482,795.03	$97,608.03	
		63,010.78	deficit
Surplus balance over all charges . .		$34,597.25	

*Taken over by Alliance Power Co., Ltd., on July 1st.

In connection with the street railway, the deficit for the first seven months of 1915 was $75,136.90, and for the first seven months of 1916 was $63,010.78, showing a betterment of $12,126.12, in spite of the fact that the city of Edmonton has decreased in population and that five battalions of her soldiers have been in camp at Calgary and elsewhere during the summer, and are still away.

Now that the laying of steel between Patricia Bay and Victoria is approaching completion the Canadian Northern Pacific Railway is about to let the contract for the substructure of the proposed bascule bridge over Selkirk Water, Victoria. Tenders were received up to Sept. 14 at the company's offices in Vancouver and Victoria, but the contract has not yet been awarded.

The Proper Education for an Engineer

The best course to pursue depends largelyu pon natural aptitudes—Graduates have weak spots

By B. G. Lamme*

In the earlier days of the Westinghouse Electric and Manufacturing Company many young technical students were taken directly into the various departments and there trained. But in time the student problem became so large and important that an educational department was developed to meet in a systematic manner the growing needs of all departments. This educational department works in conjunction with the other departments in training and in placing them where they will have opportunities in accordance with their special abilities. While the educational department supervises the student course, yet much of the training is through representatives of the commercial, manufacturing, and engineering departments.

The following remarks represent the writer's own personal opinions, based largely upon a comparatively wide experience with the young engineers who have entered the student's course during the past five or six years. In that time this company has taken into its educational department over one thousand graduates of technical schools from all over the United States and Canada. Of these several hundred have wished to specialize in engineering, while the aim of the others has been toward the manufacturing and the commercial lines, both of which require good technical training. The electrical salesman of to-day is quite technical, regardless of how he got his training. Also the complexities of the electrical business of to-day require many high-class technical men in the manufacturing departments. As to engineering, it goes without saying that those who follow this branch of the electrical business should be technical men, if they are to advance very far. In consequence, the Westinghouse Company takes on technical graduates almost exclusively for its student's course, regardless of what branch of the electrical business they expect to follow.

The writer's personal experience has been very largely with those students who expect to follow the engineering branch of electrical manufacturing. During the past few years he has come in contact with practically all those who leaned toward engineering work. One of the most important considerations in the engineering student problem has been that of fitting the men to the kinds of work for which they are best adapted. In former years this was done in a more or less haphazard manner by trying the men out in different classes of work to see whether they would make good. This procedure proved so unsatisfactory that it became necessary to adopt some method of classifying the students according to their aptitudes and abilities, and then try each one out on that line of work for which he seemed to be best fitted. Obviously this method was in the right direction, but the primary difficulty lay in determining the characteristics of the individual students. The writer has spent quite a considerable amount of time in the past few years in studying the characteristics of the students to see whether their natural and their acquired abilities can be sufficiently recognized, during the preliminary stages of the work, to allow them to be properly directed toward that field in which they will make the best progress. In this study, in which hundreds of young men were analyzed with regard to their characteristics, many very interesting points developed, quite a number of which have a direct bearing on the subject of technical training. In the first years of this study the results were very discouraging, due largely to the fact that the young men had been brought to us in a wholesale way, regardless of their characteristics or their suitability for our engineering work. Many of them had no ideas whatever in regard to the kind of work for which they were fitted. Apparently the man who had not, at least partly, made up his mind as to his preferences or his capabilities for some given line of endeavor by the time he had gone through four years of college and then entered our course, had much difficulty in making up his mind after he had been with us a year or two. It developed, in many cases, that he was lacking in decision. This was a very predominant fact in the first few years after the writer had gotten into this work more actively. After a careful study of the situation it was recommended that an attempt be made to get a different class of college men, namely, those who had more definite ideas as to what they wanted and what they were fitted for. This policy was tried, and with great improvement in the grade of men obtained.

Born With Valuable Aptitudes

One of the most prominent features which has developed from the study of these young men is that in practically all cases the most valuable aptitudes or characteristics which they have shown were possessed by them long before they entered college. In fact, many of them have apparently possessed such aptitudes, more or less developed, from comparatively early childhood. For example, the best constructing or designing engineers all had a strong tendency toward the construction of mechanical toys and apparatus in childhood. In regard to such characteristics, the schools and the colleges have merely directed and developed to a greater extent what is already there. From this viewpoint, therefore, the college simply develops. If the tendency isn't there, it would seem that there is but little use to try to develop or cultivate it. Viewed from this standpoint, quite a large percentage of the young men who take up engineering courses in college are quite unfitted for such work. Therefore, one function of the college should be to sort out and classify the young men according to their characteristics, to discourage them from following along any line of endeavor for which they have no real aptitudes, and to direct them into more suitable lines. This applies particularly to technical schools. It might be said that in our present educational system the usual method is to educate the young men and then select the real engineers, this selection being made afterwards through bitter experience. The ideal method, apparently, would be first to select the real engineers and then to educate them. In other words, those who show a natural aptitude for engineering should be educated along technical lines.

In the technical school one of the first efforts should be toward finding the student's natural aptitudes. Some boys apparently have no leaning toward any special line of endeavor. On the other hand, many boys really have some inherent preference which, however, may not have been strongly enough developed to stand out prominently. Too often his real preference has been entirely neglected or even discouraged. In the writer's own case, as a boy, he was very frequently and severely criticized for his inclination to "waste valuable time" in trying to make what were called "useless things." However, fortunately for himself, no real pressure was brought upon him to prevent him from following his preferences or tendencies, and eventually the "call" was so strong that it took him into the very work which he wanted above all else.

On the other hand, the boy may express a preference for

* Chief Engineer Westinghouse Electric & Mfg. Co.

a line of work for which he is entirely unfitted. In other words, this preference may not be based upon natural aptitudes or characteristics and is not a real "call." It is these boys, who are unfitted for the lines which they have chosen, who are a real handicap on their classmates. The class never moves along faster than its average man, and very often at the speed of the poorest men. If these poorest men were eliminated, naturally the progress would be much faster. Apparently the present methods of training have not yet overcome this difficulty, although very many teachers recognize the evil, and are attempting to correct it. This will be referred to again later.

Coming to the technical training of the students, experience indicates that too much specialization is a mistake. He gets enough of that in after years. What is needed is a good, broad training in fundamental principles. In engineering matters, a thorough grasp of such fundamentals is worth more than anything else. By fundamentals is meant basic principles or facts. These should not be confused with theories or explanations of facts. A fact is basic, and does not change, although the theories which explain it may change many times. A thorough knowledge of basic principles will enable a direct answer to be made in many cases, even where the conditions of a problem may appear to be very complex. Take, for example, the perpetual motion fallacy in its various forms. A perpetual motion scheme may be made so complex and involved and may include so many principles and appurtenances that the best analyst may be more or less puzzled to explain the various relations clearly. But by applying the principle of conservation of energy no further explanation is necessary. This one fundamental fact covers the whole case. In the same way a thorough grasp of some basic principle will often clear up the most complex problems or situations and will allow a conclusive answer to be made. With such a grasp of fundamentals one is not liable to believe that a "pinch" of some wonderful new powder or chemical, mixed with a gallon of water, will give the equivalent of a gallon of gasoline, and at the cost of a few cents. And yet this fallacy "breaks loose" periodically, and is given wide circulation in the news of the day. What is needed in such cases is a little knowlede of fundamental principles.

The Grasp of Fundamentals

This very grasp of fundamentals accustoms the boy to think for himself. In other words, it develops his analytical ability. As one educator mentioned to the writer some time ago, "If a boy has analytical ability, there is hope for him; if he has none, he is 'punk.'" By analytical ability is not necessarily meant mathematical ability with which some people are inclined to confuse it. By analytical ability is meant the ability to analyze and draw correct conclusions from the data and facts available. This faculty can be cultivated to a considerable extent, although, in the writer's opinion, it originates rather early in life. This is considered by many as the first and foremost characteristic that an engineer must have, and therefore the schools should expend their best energies in this direction.

Allied with a grasp of basic principles is the requirement of a physical conception of such principles as distinguished from the purely mathematical. This can be cultivated, as the writer's personal experience with many students has indicated. As a concrete example of the value of a physical conception the following may be cited: Three electrical engineers, familiar with induction motor design, are given some new problem regarding the action of an induction motor. One of them immediately thinks of a "circle diagram"; the second thinks of a mathematical formula; the third thinks of flux distributions and conductors cutting them at certain speeds, etc. Assuming equal mathematical skill for these three men, the one with the physical conception of the conductors cutting fluxes has a broader means for attacking the problem than either of the others can be said to have. He can tackle a new condition with better chance of success, as he goes back to the fundamental principles of the apparatus. He thus may create, confidently, new formulae and diagrams to meet new conditions and problems.

This physical conception is closely related to the development of imaginative powers, and without such powers highly developed no engineer can expect to advance far in his profession. The man with originality, resourcefulness, or with the constructive faculties well developed, or the man who "can see through things" readily, must have strong imaginative powers. This faculty also should be developed to the utmost, but should also be directed. It begins early in some children, but, unfortunately, instead of being directed, it is too often discouraged, both at home and in the school. If the boy in the public school develops a new method of solving a problem, or reaches any conclusion by other than the well-established routine way, he is criticized more often than encouraged for his departure from the beaten track, or, rather, his instructor's particular methods.

Graduates Have Woefully Weak Spots

As stated before, the student should be well trained in fundamentals or basic principles. In many branches of engineering this means that he should have a good training in mathematics. Most of the graduates of the technical schools are woefully weak in mathematics. Apparently this is not due entirely to lack of mathematical ability on the part of the students, but largely to defective training in their earlier work. One great defect in many colleges is due to passing the entrants, in algebra and trigonometry, on the basis of their high school training. In most cases this early training in algebra is very defective, as sufficient skill is not developed in the student, and the practical side is largely neglected. Algebra and its applications to geometry, trigonometry, etc., should be taught in a more practical manner in the engineering college course, as a foundation for the higher engineering mathematics. The higher the structure is to be the stronger must be the foundation. If the engineering student is not sufficiently practised in these elementary mathematics, then he should be drilled specially as a step to further engineering work. In the practical engineering work, beyond the college, skill in the use of algebra and trigonometry is of relatively much more importance than practice in the higher mathematics, for it is needed one hundred times where the other is used once. In the writer's experience with engineers he has reached the conclusion that the principal reason why mathematics are not used more in everyday work is because the average engineers have not the necessary skill. Most of them claim that they have become "rusty" in such mathematics through disuse. However, in many cases, this excuse is worse than none at all, for the occasion for such mathematics exists in practical engineering work and has been there all along.

In the education of the engineer higher mathematics forms a very valuable part of the training. One of its uses is to show how one can do without it. In other words, if properly taught, it gives a broader grasp of methods of analysis; it tends to fix certain fundamental principles. However, as a tool in actual engineering work it is seldom required, except in rather special lines. The higher mathematics might be looked upon as a fine laboratory instrument or tool, to be used on exceptional occasions, while the ordinary mathematics should be considered as an every-day tool in engineering work, and should be ready at hand at all times.

There has been quite a fad for specialization in engineering training. The writer's personal opinion is that specialization in college training is not advisable, except possibly in a very general way. There has been a false idea in many schools that if a man specialized along some individual line of work it would advance him more rapidly when he leaves school for active work. The writer almost never asks the

student in what field he specialized. It is desired to know whether he is a good analyst, if he is fairly skillful at mathematics, if he has the imaginative faculty and what goes with it. Has he initiative, resourcefulness, etc. Is he a man with a broad grasp of general principles rather than one who has made a special study of one individual subject?

In college training the time spent on commercially practical details is usually largely wasted, as it may give the student entirely wrong ideas. When a young man says that he has had a course in practical design and is positive that he can design, the chances are about ninety-nine out of one hundred that he knows nothing about the really fundamental conditions in practical design. The chances are that he does not even know the real starting point in making up a commercial design. Even worse, if he has taken such training seriously, he may have to "unlearn" many of his ideas, if the use of this term is allowable. The mental training and the aid in grasping principles which he may have obtained through his school design is, of course, worth something, but in many cases the same time expended in other channels may produce larger results. Teaching of design should, therefore, be for the purpose of exemplifying principles rather than practice. There are, of course, some lines of specialization in colleges which lead directly to practical results afterwards. Research work is one of these. However, it is probable that if a large part of the time given to research work by the student in college were expended in acquiring a broader foundation in fundamental principles the results would be better in the end.

As referred to before, there has been one serious defect in our systems of technical training to-day, namely, it holds back the leaders and pushes the laggards, thus tending toward mediocrity as the general result. There should be some system in colleges for weeding out the "negatives" in any given line of endeavor. Many of these are simply "misapplications," to use a manufacturing company term. In some other lines they may be highly successful.

In an ideal engineering course each student should be pushed to the utmost of his capabilities. One solution of this problem would be for each teacher to assign a certain amount of extra work to his students individually, and they should report to him individually on such work, explaining to him fully what they have accomplished. Each man thus could be pushed along independently of his fellows. The weaknesses of the individual men would soon appear. If, for example, it develops that certain of the students are behind in the necessary mathematics, then steps could be taken to correct this defect. Each student would have to think more for himself and would be put more or less upon his own resources. His various characteristics could be studied and developed. He should be made to work out and apply fundamental principles. He would thus practice using his own mind. As soon as it develops that he has no mind of his own, then he could be dropped. In such a course of teaching the advancement of each man would be dependent upon himself, to a large extent. At this point a principle of mechanics can be applied rather aptly. In machines a force does work in overcoming resistance. In man the same principle holds true. No matter how much force a man may have, if no resistance is presented, no result is accomplished. And if the force is small, then the result is also liable to be small. But a smaller force overcoming a large resistance may result in greater accomplishment than a larger force with but little resistance. An unusually brilliant boy with too small a task set for him may accomplish little. His task must be enlarged to suit his abilities; for, as in machines, to obtain the greatest result the resistance, or task, must be commensurate with the force acting. Unfortunately, many good men of great capabilities accomplish practically nothing, through too little resistance, due to life being made too easy for them.

Such a course of "forcing," as indicated above, might be difficult to apply in many of the schools as constituted today. But the writer's personal experience indicates that the better class of men will develop rapidly under such treatment, while the laggards are eliminated more quickly. He has tried this system in general on many graduates from the technical schools, and unusually satisfactory results have been obtained.

All of the foregoing points to the fact that the mere accumulation of knowledge is not a training nor an education. The old saying that "knowledge is power" is not technically correct any more than is the statement that torque (or force) is power, to use an engineering comparison. Torque, or force, is not power, but torque in motion is power, and, to continue this comparison, knowledge in motion, or in action, is power. Activity in some form is one of the essential factors

To sum up, the colleges should aim to develop the student's characteristics, as far as practicable. They should aim to develop analytical ability, imaginative faculty, ability to do independent thinking. They should teach fundamental principles, and the course of teaching should be such as to give the individual student a real grasp of such principles. A broad, general training is most desirable for the man who has the ability to do something in the world.

Mainly Constructional

East and West—From Coast to Coast

Montreal Demolition and Construction, Ltd., has been incorporated, with a capital stock of $20,000, head office in the city of Montreal.

"Dextras, Limitee," has been incorporated, with a capital stock of $20,000; headquarters in Montreal. The company will carry on the business of builders and contractors.

The Peter Lyall Construction Company have awarded a $100,000 contract for reinforced concrete work on the new Union Station at Toronto to the Crescent Concrete Company.

Twenty-nine of the eighty-five miles of the aqueduct in connection with the Greater Winnipeg Water District Scheme are now completed and four or five miles more are to be finished this year.

The building permits issued at London, Ont., during the month of September, 1916, numbered 81, and were valued at $39,710. The total for this year up to the end of the above month is 821, value $732,425.

Col. Thomas Cantley, president of Nova Scotia Steel and Coal Company, denies that there is any foundation for the rumor that his firm and the Dominion Iron and Steel Company are contemplating a merger.

It is hoped to have the foundations of the Ottawa parliament buildings completed before winter. Construction is to be pushed all winter, in order to have the structure ready for occupation by the fall of 1918, if possible.

The value of the building permits issued during the month of September this year in the city of Toronto was $643,372, as compared with $518,589 in September, 1915. The total value for the first 9 months was $5,006,649, against $4,741,875 during the corresponding period last year.

The value of the building permits issued at Welland, Ont., during the month of September is $12,905. For the month of September, 1915, the amount was $12,555.60. The total for the first nine months of this year is $159,123, as compared with $138,609.60 during the corresponding period last year.

The steel structural work on the Bloor Street Viaduct. Toronto, has now reached pier C, from the east; the west

side is now at pier E, which leaves only two arches to be completed. The bridge has progressed fairly well this season. The contractors hope to have finished the steel work by April next.

The contractors on the new government elevator at Vancouver, who, it is reported, were found not to have lived up to the fair wage schedule inserted in the contract by the government, have been compelled to pay the wages ordered and to hand over to a number of workmen back pay amounting to $500.

During the month of September there were 14 building permits issued in the city of Galt, Ont., value $13,905, as compared with 9 permits in September, 1915, value $7,735. The returns for the first 9 months of this year show 127 permits, at a value of $210,745, as compared with 117, at a value of $112,510, during the corresponding period last year.

Three men were killed when a cement chimney, being erected at the American Pad and Textile Company's plant at Chatham, Ont., collapsed recently, precipitating the men from the top of the chimney, a height of 80 ft. The erection of the chimney was in charge of the Webber Chimney Company, of Chicago. It was part of the $40,000 addition which was being made at the plant on Queen Street, Chatham.

For the nine months ending September building permits in Windsor represented a total of $1,088,580, a little less than the total for 1913, which was the largest year in the history of the city. Present indications are that 1916, despite the war, will outdo any previous year. There were 44 permits issued during September, this year, as compared with 34 in September, 1915, the increase in values being $39,340. Permits issued to date this year total 416.

The Nova Scotia Steel & Coal Company are turning out steel at the rate of 15,000 tons a month, as compared with less than half that amount a year ago. Col. Cantley, the company's president, estimates that the output in Canada for the entire year will be approximately 1,500,000 tons, as against 975,000 tons last year and 1,168,000 tons in 1913. If the war should stop there will still be, in the opinion of the Colonel, a strong demand for steel.

The capital of the Saskatchewan Clay Products Company has been raised from $300,000 to $500,000 in order that the company can carry out a broader plan of operation. The plant will be doubled in capacity and a gas producer installed for the burning of brick. An issue of $10,000 of the stock will shortly be thrown open to the public. The name of the new company operating under Dominion charter, will be The Dominion Fire Brick and Clay Products Company, Limited.

About 200 delegates attended the recent town-planning convention held at the Royal Connaught Hotel, in Hamilton, Ont. Mr. Thomas Adams, Dominion town-planning expert, addressed the convention. The opinion was expressed that legislation was required to provide for uniform extension of cities, and a resolution was passed calling for the appointment of a town-planning commission. Mr. Allan Studholme, M.P.P., promised to introduce a measure providing for the appointment of such a commission.

The dismantling of the old D. A. Railway bridge at Windsor, Ont., by H. J. Garson & Company, of St. John, N.B., has been recently completed. Work was commenced on July 6. A skeleton wharf was constructed, sufficiently strong to support the pontoons bearing a span, at the fall of the tide. The bearing surface of the three pontoons or scows was raised an additional 10 feet and, this accomplished, preparations were made with the assistance of a tug to receive the first small span. About two months later the last span was floated to the dismantling blocks. In all there were nine spans.

A movement is under way to bring Ontario County, Ont., into line with the Good Roads movement which is now so rapidly spreading over the province. A meeting was recently held at Uxbridge at which addresses were given by Mr. W. A. McLean, Deputy Minister of Highways, and Mr. Geo. S. Henry, M.P.P., secretary of the Ontario Good Roads Association and a member of the York Highways Commission. A resolution was carried that the meeting was of the opinion that the county should adopt the good roads system for the main roads and that those present be constituted as a Good Roads Association for the County of Ontario.

After six months of careful investigation, during which time every possible test has been made, the committee of three engineers chosen to investigate the construction of the aqueduct from Shoal Lake to Winnipeg, express the opinion that the aqueduct will carry out, in every particular, the work for which it was designed. The committee, consisting of Brig.-Gen. H. W. Ruttan, Officer Commanding Military District No. 10; J. G. Sullivan, Chief Engineer of the Canadian Pacific Railway, and R. S. Low, consulting engineer, of Montreal, was appointed in consequence of reports having been made that the work already done on the aqueduct was faulty and would have to be done over. The committee considers that the work can be completed with a total cost of $6,867,000, or about $230,000 less than the original estimate.

Personal

Mr. Walter Buchanan has resigned from the plumbing and heating firm of Buchanan, Moffat & Parr, Barrie, Ont.

Mr. W. W. Van Every, of Sault Ste. Marie, Ont., who has held the position of city engineer, has been appointed manager of the city water and light department, filling the vacancy made by the resignation of Mr. A. E. Pickering. The new city engineer is Mr. W. L. McFaul, formerly assistant.

Mr. Gordon H. Love, of the firm of Brock, Kelly & Love, has been appointed manager of the Saskatchewan Clay Products Company, which has recently been formed with headquarters at Moose Jaw. Mr. Love will continue with the former firm until the new company is ready to commence business.

Obituary

Christopher Greason, aged 75, for 39 years a resident of London, Ont., and a contractor and proprietor of a planing mill, died suddenly from heart failure at his home in St. Thomas, Ont.

In the death of Mr. E. Long, Orillia, Ont., has lost one of its most public-spirited citizens. Mr. Long was a prominent man in the life of the community, being the president of the E. Long Manufacturing Company, Ltd., and the chairman of the Orillia Water, Light, and Power Commission since its inception four years ago.

The death occurred recently of Mr. Robert Burns McLellan, aged 27, a well-known civil engineer of Vancouver. Mr. McLellan was a graduate of McGill University where he obtained the degree of B.Sc., and in partnership with Mr. R. Horie had opened an office in Vancouver as civil engineer and land surveyor, in which profession he was making a notable success.

Col. Thomas Tracy, one of the pioneer residents of Vancouver, and former city engineer for a number of years, is mourning the death of his only son, Lieut. Thomas Leonard Tracy, of the Second Pioneers Battalion, who was killed in action on September 12, "somewhere in Northern France." Lieut. Tracy was 26 years of age, and was attending McGill engineering course when the war broke out. He would have graduated this year had his course of studies not been interrupted by the call of duty to aid the Empire—a summons which he was prompt to answer. The sad news of his death reached Col. and Mrs. Tracy on September 18.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Aldboro Township, Ont.
The Township Council are considering the construction of tile drains. Clerk, E. A. Hughill, Rodney, Ont.

Chambly Basin, Que.
Plans of a filtration plant for the City Council will be prepared during the winter by J. Gravel, 17 Place D'Armes, Montreal.

Dixie, Que.
The British Remount Commission, 54 St. Catherine Street West, Montreal, are receiving tenders on the construction of about 2,000 feet of 9-inch tile sewer and 3,000 feet of 6-inch cast iron water pipe.

East Wawanosh Township, Ont.
The Township Council are considering the construction of drains. Particulars from A. Porterfield, Belgrave, Ont.

Galt, Ont.
The City Council are considering the construction of pavement on Main and Water Streets, and may start work in the spring. Clerk, J. McCartney.

Hamilton, Ont.
The City Council are about to construct asphalt pavement on Fairview Avenue, at an approximate cost of $5,000. Work will be done by the engineer, E. R. Gray.

Tenders will be called shortly for the construction of the southwest sewer, estimated to cost $14,000. Material will be 20-inch tile and 30-inch concrete pipe.

The City Council are about to construct cement sidewalks on Elm, Strachan and Province Streets under the supervision of the Engineer, E. R. Gray.

Montreal, Que.
The City Council have decided to have plans prepared for the widening of the subway on Wellington Street. Engineer, E. E. Mercier, City Hall.

Pembroke, Ont.
H. J. Beatty, William Street, who has been awarded the contract for construction of storm sewers, is receiving prices on about 4,500 feet of standard sewer pipe, 8 to 30 inch.

Smith's Falls, Ont.
The Town Council are considering the construction of a filtration plant, at an approximate cost of $20,000. Engineer, S. B. Code.

CONTRACTS AWARDED

Gosfield Township, Ont.
The Township Council have let the contract for drainage work to George B. London, care of W. E. Noble, Cottam, at $3,500.

Ingersoll, Ont.
The Town Council have let the contract for construction of pavement and storm sewers on King Street West to McRae & Campaigne, Niagara Falls, Ont.

Lindsay, Ont.
In connection with the construction of sewers on Kent and Mary Streets, the Town Council have let the contract for supply of 12-inch pipe to Cinnamon & Allin, and for 15-inch pipe to McLennan & Company.

London, Ont.
The City Council have let the following contracts for construction of sanitary sewers: J. Murphy, care of the Clerk, approximately $5,900; W. J. Johnston Company, care of the Clerk, $3,913.

St. Lambert, Que.
The Town Council have awarded the contract for construction of a sewer on McCullough Avenue to Dekeyser Poismans Company, 1101 St. Valier Street, Montreal. Approximate cost, $4,850.

Weston, Ont.
The Town Council have awarded the contract for construction of watermains to Johnstone Brothers, Weston.

Railroads, Bridges and Wharves

Preston, Ont.
The Town Council are considering the erection of a bridge, at an approximate cost of $40,000. Work may start next year. Engineer, C. S. McKenzie.

CONTRACTS AWARDED

Lansdowne Township, Ont.
The ownship Council have let the contract for construction of a steel and concrete bridge to John Donovan, Lansdowne. Engineer, D. Dempster, Route 3, Gananoque.

Maidestone Cross, Ont.
The Essex County Council have awarded the contract for construction of two concrete bridges to W. J. Wyatt, Cottam, Ont.

St. Jean Baptiste, Que.
The Municipal Council have awarded the contract for the construction of a steel and concrete bridge to N. Tetrault, A. Roy and A. Chigcoine, at $3,183.

Public Buildings, Churches and Schools

Bangor, Sask.
The Trustees of School District No. 1141 have been empowered to borrow $4,500 for the erection of a school. Treasurer, W. E. Havard, Bangor.

Hoosier, Sask.
The Trustees of School District No. 1145 have been empowered to borrow $6,700 for the erection and equipment of a school. Treasurer, William Petit, Hoosier.

Ingersoll, Ont.
The Public School Board are considering the erection of a school on Thames Street at an approximate cost of $70,000, and a by-law will probably be submitted in January. Architect not yet appointed.

Kitchener, Ont.
The Sisters of Charity, Kingston, are considering the erection of a hospital at an approximate cost of $60,000. Architect not yet appointed.

Palmerston, Ont.
Tenders on post-office fittings will be received until 4 p.m., October 18th, by R. C. Desrochers, Department of Public Works, Ottawa. Plans and specifications at office of Clerk of Works, Palmerston, at Postal Station F, Toronto, and at the Department. Specifications only at office of MacLean Daily Reports, Ltd., 25 Charlotte Street, Toronto.

Phillipsburg, Ont.
The School Trustees are considering the erection of a school at an approximate cost of $5,000, and propose to start work in the spring. Particulars from E. D. Eidt, Baden, Ont. ... ...

Ste. Perpetue, Que.
Tenders on the erection of a Parish Church will be called about the middle of next month. Architect, P. Levesque, 115 St. John Street, Quebec. Approximate cost, $12,000.

CONTRACTS AWARDED

Brampton, Ont.
The Department of Public Works, Ottawa, have let the contract for electric wiring and fittings at the Public Building to W. K. Young & Company, Brampton.

Calgary, Alta.
The general contract for the erection of a drill hall has been let by the Department of Public Works, Ottawa, to A. G. Creelman & Company, 23 Crown Block. Steel, brick and stone construction. Approximate cost, $99,000.

Haileybury, Ont.
The following contracts have been let in connection with the erection of a School of Mines:—cut stone, Ritchie Cut Stone Company, 191 Grant Avenue, Hamilton; steel, Canadian Bridge Company, Walkerville; reinforcement and steel sash, Trussed Concrete Steel Company, Walkerville; roofing and sheet metal, F. R. Gibson, Haileybury; painting, E. Hargreaves, Haileybury; plumbing, F. R. Gibson, Haileybury; electrical work, D. Clathy, Haileybury.

Hamilton, Ont.
The following contracts have been let for the erection of a military barracks for the City Council:—general contract and carpentry, City Engineer, $34,770; tinsmithing, F. Irwin & Sons, 22 McNab Street South; painting, P. Thompson, 13 Walnut Street North; plumbing, P. A. Moore, 939 King Street East; sewers, S. Cheeseman, 644 King Street West.

Ingersoll, Ont.
The following contracts have been let in connection with the hospital addition which is now being built:—roofing, W. Scott, 506 York Street, London; painting, Lewis Brothers, 179 Mill Street, London; heating and plumbing, Howe & Henderson, Thames Street. Tenders are now being received on plastering and electrical work.

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Inventory of Man Power

THE Canadian Government is at last moving slowly in the matter both of an inventory of our man-power and of the conservation of our financial resources, and, inasmuch as we have seen no reason to change our viewpoint of many months ago, it is gratifying to note that it is following along lines entirely identical with those urged time and again, to the best of our ability, in these pages. For example, it is announced by Sir Thomas Tait that an "inventory of man-power" will be taken —a term used for the first time, we believe, in the Contract Record when, on various occasions, we urged this as the right line of action for the government to follow.

It is also equally gratifying to note that the department of finance will shortly make public the details of a plan of encouraging savings by offering greater inducements to invest small amounts which will also yield higher interest returns. Several months ago we pointed to the futility of our government savings departments and our chartered banks, with their 3 per cent. interest, as any real inducement to the working man, and we urged at that time that the government may well increase their rate of interest so that the small investors would thereby be induced to save their money, and, in so doing, prepare to participate in such issues as the recent Dominion loans. Splendid as has been the response to these issues it cannot be overlooked that the support comes almost entirely from the "saving" class and scarcely at all from the mass of working men and women who, though to-day more prosperous than ever before, are in reality more improvident. In our editorial of January 5, this year, for example, we said on this point: "We suggest that the government take steps to induce the working people of Canada and others to save their surplus. Let the government stop playing with its 3 per cent. toy and offer a real inducement to the working man, now well supplied with money, to save his surplus." We hope, now that the government shows signs of acting, that it will not stop short of making the inducement to the small investor really worth while.

Support Your Engineering Societies

NOW that the season of society activities has come around again we should like to commend to young Canadian engineers (and some of the older ones, too,) the sentiments contained in an article which recently appeared in the Bulletin of the Oregon Society of Engineers from which we print extracts below. One is frequently struck with the comparatively small attendance at the branch meetings of our Canadian Society of Civil Engineers and the American Society of Electrical Engineers, the two most active of our engineering bodies, where even discussions of the most timely interest, or lectures by men of pre-eminent standing in their particular field, fail to arouse the interest of more than a small percentage of the engineers within easy reach. Now that the Canadian Society in particular and, we hope, Canadian engineers in general, have decided to look upon life more with the eye of the business man and less with that of the sentimentalist, they would do well, we believe, to consider just how far their business interests would be served by joining in, a little more heartily, with their engineering societies' activities, getting a little better acquainted and contributing a little more to the interest of the work by verbal discussions and written contributions—in a word, doing their "bit." The societies would be more prosperous and, so we take it, would the individuals:

"Many engineers have a notion that acquaintanceship with other engineers, while agreeable enough, so far as it goes, doesn't really amount to anything where dollars and cents are concerned; and these deluded individuals are expending their substance in 'putting up a front' and otherwise cultivating the acquaintance of men of other professions.

"Now I am not going to say anything against the other professions, nor the men in them, but I honestly believe that for practical purposes the acquaintance of one engineer is worth to an engineer that of half a dozen other men. In my own case it has proved true. Total strangers have walked into my office and given me better jobs than I knew were available—sent to me by engineer friends—while the best that I could get out of the other acquaintances might be a chance

to stake out a lot—at half price—as a neighborly act, you know. And they make a fellow feel at the same time that they are giving him the work largely as an act of charity.

"There are four or five hundred engineers in and around Portland. How many of them do you know? How many of them know of you? If you were asked to design a bridge or a power station, and were too busy or didn't know how, could you recommend a man to do the work? Or to reverse the case, how many of the five hundred engineers in this vicinity know your specialty and your qualifications?

"I'm willing to bet that they are mighty few. Maybe it is just as well, too, for frequently those who know me tell me that I have missed my calling; and they may be right about it. Quien sabe?

"You may have missed your calling, also, in which case the greater the secrecy surrounding you, the greater will be your chances of success as an engineer.

"But supposing that you are an engineer, and a good one, which is, after all, the only assumption that we can proceed upon, can you not see that it will be distinctly to your advantage to have all of the other good engineers in the community know what you can do and how well you can do it, as well as to know some of the things that you have done in the past?

"Perhaps you are employed now, and are satisfied with the surroundings and salary, and that there is no prospect of a change. Hundreds of others have been in the same circumstances one day, and the next have been left high and dry, through no fault of their own, with no job, and no knowledge of how to get one. Wouldn't their chance of immediate re-employment have been increased greatly if they had been widely and favorably known among the engineers of their town?

"Possibly. But how could they or you achieve such a result without too great a cost?

"By joining a local engineering society, and by attending the meetings and when there by 'mixing.' Make it a point to meet one or two or a dozen new engineers every month. Find out what they have done and are doing and hope to do, and don't be too modest. Let them know who you are and what part of the world your work supports.

"Search out the chairman of the program committee and drop a hint that you have some interesting lantern slides showing a work upon which you were engaged before coming here and if properly pressed will consent to show them to the society and explain the peculiarities of the work.

"Look up the publication committee chairman and tell him that you have written, or will be glad to write, a description of some of your experiences in China or Nebraska, as the case may be, if he can use such matter to advantage—which you bet he can.

"When a subject is up for discussion upon which you are informed or wish information, tell what you know, or ask such questions as will bring out the information you seek. Others will thank you, and will form a favorable opinion of your professional skill.

"And if you are in private practice, supplement these methods with a card in the society's year book and another in its journal. This will keep your name before those who can do you the most good."

There are references to the existence of bituminous macadam roads as early as 1838, which proves that such pavements are not of as recent origin as sometimes imagined.

Demand for Highway Engineers

College and university students who specialize in the highway engineering branches of civil engineering courses will find unusual opportunities henceforth of securing early employment and good pay after winning their degrees.

There has long been a decided lack of trained road engineers and the demand for them is increasing rapidly. Probably no other branch in engineering offers such sure reward at this time.

Eighteen state highway commissions out of twenty-four reporting to the National Automobile Chamber of Commerce in New York City state that there is a lack of trained road engineers, and sixteen say that preference would be given to graduates of college highway engineering courses in the appointment of additional road engineers.

Nearly 1,600 engineers are now employed by the twenty-four state commissions, and in addition about 2,000 are employed as county and city engineers in nineteen of the states.

Salaries of highway engineers range from $900 to $5,000 a year. The average is about $1,800.

There has been a tremendous increase in highway improvement throughout the country during recent years and the demand for good roads is growing rapidly. Highway commissioners report that they anticipate the number of engineers employed by the state highway departments will be doubled within five years. —Cement World.

Prince Rupert's Superior Facilities

Criticism has been rife as to the reason why advantage has not been taken of the existence at Prince Rupert of one of the finest shipbuilding and drydock plants to be found on the Pacific Coast—a plant completed only a couple of years ago, at a cost of nearly $3,000,000. Several offers to lease it have been made by Vancouver firms who are desirous of starting shipbuilding operations, but it seems that the government and the G.T.P. management have to arrive at some agreement before the dock and shipyard can be taken over. With every plant on the Pacific Coast busy turning out ships and an ever-increasing demand for vessels, it is almost disloyal to permit anything to stand in the way of the utilization of Prince Rupert's superior facilities. Four or five hundred men, it is claimed, should have been at work there for months past.

Much Deferred Construction

The scheme to connect the cities of Vancouver and North Vancouver by means of a $2,000,000 bridge at Second Narrows is only one of a number of big enterprises which have been interfered with by the war. At a business meeting of the Burrard Inlet Bridge and Tunnel Company, held recently, Mayor McBeath, of Vancouver, succeeded F. Carter-Cotton as president, the latter asking to be relieved owing to press of other duties. The former directors were re-elected.

There are 8,757 vessels registered in Canada, of which 4,312 are steamers. The tonnage amounts to 929,312. The number of vessels constructed in Canada last year was 246 of 18,832 tons, compared with 329 of 43,000 tons during the previous year. Over 45,000 sailors are serving on board these ships.

The Greater Winnipeg Aqueduct

Report of Special Committee of Engineers on Extent of Cracks, their Cause, and the Best Method of Repairs and Maintenance—Adverse Conditions Met in Construction

IN view of the very general interest taken by engineers in the work of the Greater Winnipeg Water District scheme of withdrawing water from Shoal Lake and transmitting it by concrete aqueduct to Winnipeg, a distance of some 85 miles, and in view, further, of the faults which developed in the concrete pipe during the early summer, our readers will be interested in the report just issued by the special board of consulting engineers, comprising Col. H. N. Ruttan, Winnipeg; Mr. J. G. Sullivan, Winnipeg, and Mr. R. S. Lea, Montreal. It will be recalled that following the discovery of these faults, the Administration Board of the Greater Winnipeg Water District submitted a number of questions to the chief engineer and the consulting engineer on this work, Mr. W. G. Chase, Winnipeg, and Mr. James H. Fuertes, New York. However, when the report of these two engineers was received, it was considered by the Administration Board that a further report by engineers who had not been associated with this work would be in the best interests of the city, and in the appointment of this board, as mentioned above, the same twelve questions were submitted for their consideration. During the intervening months this special board of consulting engineers have carefully considered these questions from their various angles, and the report now submitted consists chiefly in a reply thereto. The earlier part of the report deals with many conditions met by the board in carrying out this work, but is omitted here, having been covered already in more or less detail in the Contract Record. The questions and the answers thereto, however, are particularly interesting as throwing a great deal of light on the conditions surrounding the building of the Winnipeg aqueduct, and we reproduce these in full herewith:

Questions

Specific answers to the questions submitted to the consulting engineer and the chief engineer and later to the special board of consulting engineers:—

Question 1.—What is the extent of the cracks in the aqueduct?

Answer.—The construction of the arch form of aqueduct was carried on at ten different points during 1915, and altogether 65,390 feet or about 12.4 miles, was completed. In 13,380 feet of this total length invert cracks have developed, usually a single crack along the middle of the invert but in a few cases, in badly cracked sections, at the side walls of the arch as well.

Close observation has been kept of these cracks from their first appearance, and by the use of "telltales" consisting of smooth pats of cement trowelled across the cracks any enlargement has been promptly detected and recorded. The last sign of movement was observed at the beginning of April, since which time there has been no indication that any further settlement has taken place.

In regard to the size of the cracks, these inverts may be grouped as follows:—

In 4,815 feet the cracks vary in width from 1/16th of an inch to one-fourth of an inch, and in a few cases slightly larger. A total of 4,017 feet has cracks from 1/64th in. to 1/16th in. In the remainder, 5,193 feet, the cracks are merely hair cracks which can only be discovered by very careful examination. In many of the arches where the invert cracks are of any considerable size, corresponding cracks have occurred along the crown. In four arches where the backfilling was improperly done, frost action has caused cracks along each haunch. A few arch cracks have been accidentally caused in removing the forms and small cracks have appeared due to temperature changes, etc., most of which had been formed before any load had been placed upon the arch.

Question 2.—Are the cracks continuous over a certain part of the work or do they recur in various sections of the work?

Answer.—The location and extent of the sections of the 1915 work which have invert cracks are as follows:—

Contract 30

	Feet
Mile 23	
Total length of aqueduct built	13,930
Length of invert with cracks 1/16 in. to 5/16 in. in width	4,305
Length of invert with cracks 1/64 in. to 1/16 in. in width	1,620
Length of invert with hair cracks only	225
Mile 24	
Total length of aqueduct built	7,405
Length of invert with cracks 1/64 in. to 1/16 in. in width	390
Length with hair cracks only	2,025

These two sections, which are continuous, not only include about two-thirds of all the cracked inverts, but nearly all the cracks above 1/16 in. in width.

Contract 31

	Feet
Mile 33	
Total length of aqueduct built	5,925
Length of invert with cracks 1/64 in. to 1/16 in. in width	135
Length with hair line cracks only	480
Mile 43	
Total length of aqueduct built	5,055
Length of invert with cracks 1/16 in. to 5/16 in. in width	450
Length of invert with cracks 1/64 in. to 1/16 in. in width	35
Length with hair line cracks only	1,140

At the west end of this work several alternate sections of invert amounting to 645 lineal feet had been laid when the work closed down for the season. These were covered with earth for protection, but not sufficiently to prevent their being cracked by frost.

Contract 32

	Feet
Miles 51, 57 and 65	
Total length of aqueduct built	28,821
Length of invert with hair line cracks	1,155

Contract 33

	Feet
Mile 71	
Total length of aqueduct built	6,080
Length of invert with cracks 1/64 to 1/16 in.	

in width	170
Mile 77	
Total length of aqueduct built	4,033
Length of invert with cracks 1/64 in. to 1/16 in. in width	812
Length with hair line cracks	203

Contract 34

Mile 85	Feet
Total length of aqueduct built	5,266
Length with cracks 1/64 in. to 1/16 in. in width	210

Qestion 3.—What caused the cracks?

Answer.—The sections of the work will be referred to in the same order as in the answer to Question 2.

Contract 30

This work is all in the "prairie section." The material is clay, and at Mile 23, and where the cracks occur at Mile 24, the cut is shallow, generally between one and a half and four feet in depth. The type of invert referred to as the "standard invert for firm soil" was used.

As has already been stated, the cracks formed at this point are much more extensive and much larger than in other portions of the work and are practically continuous throughout the whole length at Mile 23. The bearing power of the material at this point has proved to be much less than was anticipated and as a consequence the considerable settlement under the load as distributed by the type of invert used has resulted in the cracking of the invert and then of the arch as referred to above.

Contract 31

Mile 43.—This section is on the east slope of the Brokenhead River Valley. The cut varies from two feet at each end to seven or eight feet near the middle, but is for the greater part less than five feet in depth. The material in the shallowest portions at the ends of the section is black clay which has been removed and replaced with rolled embankment and water settled embankment. Otherwise the material is noted as moist sand with springs, sandy clay with boulders, and some hardpan.

All of the larger cracks and nearly all of the others have occurred in the shallower cuts. The 450 feet of cracks previously referred to larger than 1/16 in., are near the west end. The subsoil is referred to by the division engineer as "moist sand with tendency to springs." All of the invert cracks and most of the arch cracks have been caused, as in the cases previously referred to, by the settlement under the side walls, much of which (and probably the greater part) was apparently due to insufficient protection of the trench bottom before the inverts were put in place.

The exceptions noted in the case of the arch cracks are the side cracks in the four arches referred to in replying to Question 2. These arches are located in the deep cut and were backfilled in wet trench with very wet material which froze solidly to the top and sides. The resulting expansion cracked the arch along the sides clear through and to a width of one-quarter inch or more. These cracks closed up completely with the advent of warm weather except for a short distance where loose material had gained entrance.

Contract 32

The sections built in 1915 were at Miles 51, 57 and 65. The subsoil material is sandy clay with boulders, and nearly clean sand. The same type of invert was used here, and out of 22,320 feet of work built, 21,166 feet is free from settlement cracks. The 1,154 feet remaining, in which only hair cracks have appeared, are all in cuts in which the material is largely peat or muskeg, only a foot or two in the bottom of the trench being in the firm material, generally compact clay. These cracks have been caused as before by settlement, and indicate that in such shallow depths of the firm material underlying muskeg, the use of an invert providing somewhat greater bearing area is advisable.

Contract 33

Mile 71.—With the exception of the first 1300 feet which is on foundation fill, this section is in deep cut and the material is fine sand with a few boulders, hardpan and solid rock. Only 170 feet of the 6,060 feet constructed has invert cracks. These are on foundation fill in the middle of a rock cut and on hardpan, and are due to imperfect drainage and preparation of the trench bottom.

Mile 77.—The invert cracks in this section are partly in shallow pockets of clay and partly on foundation fill in a rock cut and on each side of it. In the latter case the cracks are to be attributed to the same cause as at Mile 71.

Contract 34

Mile 85.—Only 210 feet of this work has invert cracks. The aqueduct at this point is in deep cut and adjacent to a stretch of 700 feet where the conditions in the trench bottom required the use of pile foundations. This part of the work was flooded soon after it was backfilled and remained so until the present season's work had begun.

In a number of the cases noted in the preceding paragraphs, the occurrence of cracks may be said to be more or less incidental to construction operations, and to be expected in work of this character and extent.

As previously explained, copper expansion joints are placed between each 45-foot length of arch to provide for the effects of temperature changes. In spite of this, in some parts of the work, transverse cracks have appeared between the joints before the protective cover of the embankment has been put in place. They are generally small and largely confined to the upper part of the arch. The backfilling on the 1915 work was postponed till the end of the season. If the backfilling had closely followed the arch construction, the appearance of cracks due to settlement would have suggested and permitted the prompt adoption of measures which would have prevented the most of those which have occurred.

Question 4.—What will be the result of the cracks?

Answer.—This has been fully stated in the answers to other questions. There will, of course, be the trouble and expense of making the necessary repairs; but other than this we do not anticipate any result prejudicial to the permanence or utility of the aqueduct.

Question 5.—What is the cost of the work affected by the cracks?

Answer.—This information has been supplied to us by the chief engineer as follows:—

The cost of the portion of the entire aqueduct structure in which these settlement cracks have occurred is $104,360. The cost of the invert alone is $34,198.

Question 6.—Can the damaged work be repaired to be efficient or will it have to be removed?

Answer.—The damaged work can be repaired to

be as permanent and efficient as other portions of the aqueduct.

As a result of our observations, and of hydrostatic and other tests which have been made during the present season on portions of the completed aqueduct, we are of the opinion that none of the work so far built will have to be removed.

Question 7.—If it can be repaired, explain how?

Answer.—The necessary repair work consists in effectively and permanently closing the cracks through which water can enter or escape from the aqueduct.

There is no lack of experience and precedent in regard to the repair of cracks in structures of this kind. The general method is to enlarge the cracks to a depth of two inches or so and fill them with cement, asphalt mixtures, lead wool, etc. Where the construction is of brick or there is a brick lining it has occasionally been found necessary to insert pipes and force in grout under pressure. In extreme cases impervious linings of some degree of flexibility have been employed.

In the Shoal Lake aqueduct the cracks are, as explained previously, largely due to settlement, and when the invert has come to a permanent bearing and settlement has ceased there will be no further tendency for these cracks to open.

The method of repair it is proposed to use, and which has already been used, is as follows:—The section to be repaired is thoroughly cleaned. The cracks are cut out to a depth of one and a half to two inches and to a width of about one inch. This groove, as far as possible, is made wider at the bottom than at the top and never "V" shaped. It is carefully cleaned with water and then packed with neat cement slightly moistened and hammered solidly into place, using a special caulking tool. This makes not only an exceedingly tight joint, but a very strong one. Several sections of invert, including portions of these joints, have been cut out and tested. The cement filling, even after having been in place only two or three days, adheres so strongly to the concrete that when broken the break has generally been in the old concrete, sometimes in the filling, but never at the junction of the two.

Two sections of aqueduct at mile 23, each about 270 feet in length, and purposely selected to include the most seriously damaged portion of the 1915 work, were repaired in this way in July last. Watertight bulkheads were built at each end of the sections which were then filled with water to the level corresponding to the rated discharge of eighty-five million gallons per day. Since then daily records have been kept of the loss of water as indicated by the fall in level, and are being continued.

The results so far are very satisfactory. The total loss at the present time is only about 250 gallons per day from each section, each of which has between 200 and 300 lineal feet of expansion joint below water level, and the quantity lost could escape through a single hole the size of a match. The result shows that the cracks have been very thoroughly closed.

The loss of water stated is equivalent to less than 5,000 gallons per mile of aqueduct which is much less than the limit usually specified in large concrete pipes under low heads.

Tests made in April, 1915, in Philadelphia, on 36-in. reinforced concrete pipes under a pressure of 5 lbs. per square inch gave a leakage at a rate from 7,920 to 15,840 gallons per mile.

The limit of permissible leakage to be specified for the 5 ft. 6 in. concrete pipe from Deacon to the Red River has been set at 12,000 gallons per mile.

The evidence furnished by a series of tests of portions of the completed aqueduct provided with special facilities for accurate observations of settlement, taken in connection with the fact that no settlement has taken place in the cracked sections since early in April, gives some indications that in most, if not all, of these sections, the aqueduct has come to a permanent bearing. There is plenty of time to obtain assurance of this, and, until another year's experience is available, it would probably be advisable to restrict repair work to what may be required to secure such further information as may be considered necessary in the meantime.

The entire cost of the repairs described above, including labor, materials and incidentals, amounts to about 93 cents per lineal foot of aqueduct. As the sections repaired are of large size and were cracked more seriously and extensively than other parts of the 1915 work, the average cost per foot of such repairs will no doubt be much less; so that even if much of it should have to be done over again, the total cost of repairing will probably not be very great.

Question 8.—Is anything being done to repair recent damage?

Answer.—The only repair work which has so far been undertaken is that referred to in the reply to question 7.

Question 9.—What action do you propose to take to avoid a recurrence of similar defects in the work yet to be constructed?

Answer.—On April 29th last, the following communication was received from the late Commissioner Reynolds:—

Greater Winnipeg Water District
Winnipeg, 28th April, 1916.

Col. H. N. Ruttan,
Winnipeg, Man.

"Dear Sir:

"The Administration Board of the Greater Winnipeg Water District requested me at a special meeting of the Board held to-day to request that you convene the Board of Independent Consulting Engineers appointed to report on the Shoal Lake Aqueduct at the earliest possible time, and that you make an inspection of the works as soon as possible with a view to advising, if possible, that in your opinion the work at some point should be proceeded with. The Contractors, in many instances, are ready to begin actual construction. They have an expensive plant and an expensive organization. The contract calls for the work to be completed within a certain specified time. To accomplish this, advantage will have to be taken of all the time at their disposal. You can appreciate, therefore, the Board's desire that at least an interim report be received from your Board at the earliest possible date.

"Yours truly,
"(Signed) S. H. Reynolds,
Chairman of Commissioners"

In response to this the following interim report was submitted:

Mr. S. H. Reynolds, C.E., Winnipeg, May 5th, 1916
Chairman of Commission,
Greater Winnipeg Water District,
City.

"Dear Sir:

"Referring to your instructions of the 11th of March last and your further communication of the 28th of April,

the undersigned beg to state that they have held several meetings, some with yourself and the engineers of the Commission, and that they have examined as far as the season and weather conditions would admit, the works in question.

"While a good general idea of the subject has been reached several experiments on the bearing power of the foundations, and further opportunities of examining the effect of the constructions already made on the many and various conditions existing in the foundations are necessary before a final report can be submitted on the questions asked in yours of the 11th of March, 1916.

"With regard to yours of the 28th of April, and in view of the reasons stated in the communication, for the desirability of the immediate and safe prosecution of the works referred, we beg to recommend that the construction of the aqueduct be proceeded with as recommended by your engineers on the following basis:—

"(1) That on foundations of boulder clay, hardpan and gravel, the "Standard Section" be used, with the addition of extensions of the base on both sides as shown in the engineers' plan D-317.

"(2) That in foundations less firm than the above, the sections showing distributed load on the full width of the aqueduct D-317, be used.

"Note:—The projection of the foundation shown in the left of this section may be changed to 8 inches, if the cost of excavation can thereby be reduced.

"(3) That the circular section as designed for laying which preparations are being made, be gone on with.

"It is distinctly understood that the above recommendation made be modified when the results of the investigations and experiments now being made are available, and indicate that less substantial construction may be safely adopted."

Yours respectfully,

(Signed) H. N. Ruttan,
J. G. Sullivan,
R. S. Lea.

The first recommendation refers to the unreinforced type of invert illustrated in Figure 1, but with 8-inch extensions on each side. It also restricts its use to the hardest foundations. The effect of the extensions is to reduce the maximum intensity of pressure on the foundations by about one-half.

This recommendation was made notwithstanding the fact that nearly ten miles of the 1915 work, with similar inverts, but without extensions, had stood without crack or other indication of undue settlement.

On account of the lack of information referred to and the unavoidably limited opportunities for personal investigation, and in view of the circumstances generally, the extensions were recommended to be used, for the time being, in all cases, and have been so used in all of the 1916 work to date. They are probably being now used in many places where they are unnecessary, and in the future the extent to which they may be employed should be decided by the engineers.

As a similar precautionary measure to provide against the uncertainties existing at the time, the second recommendation advised the use, in all of the compressible soils, of one of the heavy reinforced inverts designed by the engineers, also with eight-inch extensions. This design has been used throughout the 1916 work except where the character of the foundation, in the judgment of the engineers, justified the use of the plain extended invert.

About fifteen miles of aqueduct has been constructed during the present season in accordance with these recommendations, and the greater part of it has been backfilled. So far no settlement cracks have developed in any of this work.

Since the date of the interim report, however, a considerable number of observations and experiments have been made which have enabled us to satisfy ourselves regarding certain doubtful points. Twelve two-hundred-foot lengths of aqueduct located at different points along the line, of different sizes and on a variety of foundations, were carefully observed and tested for settlement under load. The inverts were either one or the other of those just described. Results have also been obtained from tests made on other sections with inverts further extended and of different form but without reinforcement.

The reinforced invert in use is designed to distribute the load over the entire width of the base of the aqueduct. This reduces the unit pressure to such a small amount that the eight-inch extensions are unnecessary and can be safely omitted.

Furthermore, the engineers have based their design on maximum unit stresses of only 10,000 lbs. per square inch in the steel and 500 lbs. per square inch compression in the concrete, with liberal assumptions as to the manner in which the load will in general be distributed.

Between the reinforced invert, distributing the load over the entire width of the base of the aqueduct, and the plain invert with eight-inch extensions, there is a wide difference in the pressure imposed upon the foundations. There are evidently intermediate designs which may be safely and advantageously employed.

A series of experiments is now being carried on by your engineers on sections of invert of different depths and with different percentages of reinforcement. These inverts are built in place in the trench and careful tests will be made with each type. The results will indicate the modifications which may be made in the designs and the extent to which they may be used. These are matters upon which no pronouncement can be made in advance, but which must be left to the judgment of the engineers in charge of the work.

Transverse cracks in the arch between expansion joints can, we believe, be largely and perhaps entirely prevented by closely following up the arch construction with embankment.

Question 10.—In the light of experience, do you consider the present design still suitable for the country traversed? If so, why? If not, what change will require to be made, and what will be the cost of construction under altered designs?

Answer.—The reply to these questions with the exception of the reference to cost has been given in the answer to the preceding question, and elsewhere in the report under the heading "Design of the Aqueduct." The cost per foot will vary with the size of the aqueduct section and the depth of cut.

About twenty-seven miles of the aqueduct have now been built and about half of the excavation completed. The information obtained from the actual exposure of the sub-soil at so many different points, together with that derived from soundings, surface indications, etc., enable a pretty close estimate to be made of the character of the materials which are likely to be met with in the different portions of the remaining excavations. Such estimates have been made by the engineers and submitted for our information. They indicate that if construction were to be continued as at present without any modification of the designs, except the omission of extensions to the reinforced in-

verts, the total increase in cost would be in the vicinity of $500,000. If it is found that intermediate forms of reinforced invert less heavily reinforced may be safely used in portions of the work, this amount will be materially reduced.

In this connection we are informed that the original estimate of the cost of the aqueduct from Deacon to the Intake, including the cost of the cement, and based on the contract quantities of the different items, amounted to $7,097,640. In these quantities a liberal allowance was made to cover contingencies, uncertainties as to foundations, etc.

A revised estimate based on the accurate information now available, and including the cost of continuing the present expensive methods of constructing the inverts amounts to only $6,867,700. According to the above estimates, which have been furnished us by your engineers, the aqueduct will be completed under the modified designs well within the original estimates.

Question 11.—Have the designs and detailed plans of Messrs. Hering, Stearns and Fuertes been closely followed or have they been varied in any way or departed from in construction of the work so far? If so, why, and by whose authority? Were the Commissioners or Advisory Board advised of such changes?

Answer.—The designs and plans of Messrs. Hering, Stearns and Fuertes referred to are the general plans accompanying their report upon the project of bringing water from Shoal Lake to Winnipeg. The scheme recommended was a gravity flow concrete aqueduct from the Lake to the site of the future reservoir at Transcona, having a rated capacity of eighty-five million Imperial gallons per twenty-four hours, and a pipe line of steel and cast iron of smaller capacity from there to the reservoir at McPhillips Street. The general scheme proposed in the report has not been departed from and the plans have not been varied in any essential with the exception of the pipe from Deacon to the Red River, the change in which has been approved by Messrs. Hering and Stearns in a special report, and later by the undersigned.

The preliminary surveys upon which the original report was based were made in sufficient detail to demonstrate the feasibility of the project, to obtain an approximate location for the line, and to enable a fair estimate to be made of the probable cost of the work. When the undertaking had been authorized a series of very careful surveys was made to find the best possible location for the aqueduct from the point of view of character of foundation, efficiency and economy. The final location and the corresponding grades and sizes of aqueduct naturally vary somewhat from those given in the Hering, Stearns and Fuertes report.

The site for the future distributing reservoir was changed to the present location at Deacon, which, being on higher ground, enables a reservoir of equal capacity to be built at lower cost. We understand also that the land necessary for the purpose was obtained for much less than the price asked for the original site.

As regards the plans of the aqueduct itself which accompanied the report, they consist of a number of typical cross sections of the different sizes suitable to the approximate line and profile. The arch designs have been closely followed in the final plans, the slight variation in form being, in our opinion, in the way of improvement. The inverts are practically identical, in form and dimensions, with the present standard unreinforced invert for use in firm material.

Briefly, the designs and plans signed by Messrs. Hering, Stearns and Fuertes have not been departed from in principle. The detailed contract plans, which are based on accurate information and painstaking study, are naturally better suited to the purpose intended than those accompanying the report, which cannot, and were not, intended to be considered as working plans.

Question 12.—Were the changes, if any, submitted to the full Board of Consulting Engineers and approved by them? If not, why not?

Answer.—As a matter of convenience of reference, we quote from the statement made by Messrs. Fuertes and Chace in their report of February 16th last.

"None of the plans upon which the work has so far been built were submitted to Messrs. Hering and Stearns. The Engineers subscribing to this communication, not having departed from the designs of Hering, Stearns and Fuertes, in adapting the new designs to local conditions, saw no reason to ask for the submission of the final plans to the original Board of Consulting Engineers, whose terms of service, as a Board, terminated with the submission of their report to the City of Winnipeg."

Conclusion

The practical questions to be answered in connection with the project are:

(1) When the aqueduct and its accessories are completed will the works be of such a character that they will satisfactorily perform the service for which they have been designed, viz., the delivery of Shoal Lake water to the city of Winnipeg and the surrounding municipalities in the quantities specified and without pollution on the way?

(2) Will the work as projected be of such a substantial and permanent character as to require only a reasonable charge for maintenance?

(3) Will the cost of the completed work be fair and reasonable?

Subject to the careful carrying out of the work on the lines indicated in this report all the questions may be answered in the affirmative.

Reference has been made in this report to hydrostatic tests of two of the repaired sections of the aqueduct, in which the loss of water was much below the permissible limit of good practice. Further tests which are being carried on at the present time show still better results.

By the use of steel arch forms and by careful attention to details by the workmen an interior surface of unusual smoothness has been obtained, the effect of which will be to materially increase the discharge capacity of the aqueduct above that estimated. These results could only be obtained with concrete of the highest quality both as to materials and workmanship.

The cost of the completed work according to the latest estimate will compare advantageously with that of similar works anywhere, when the capacity and length of line are considered.

The Montreal Tramways Company are adding to their sub-stations. Tenders have been received for a one-storey building, 50 x 100, at the corner of Archambault and Notre Dame Street East, Pointe-aux-Trembles. The foundations are to be of concrete and granite, and the superstructure of brick and terra cotta. Plans are also being prepared for another sub-station at Cote Street, Montreal, of similar design, on a site 100 x 100.

A Large Steel Sheet Pile Cofferdam

Several Novel and Interesting Features — Diagrams Show General Plan of the Work — Pulling the Piles with Steam Hammers

THE following description is an account of the methods employed in constructing a large steel sheet pile cofferdam in connection with the new Forty-sixth Street pier at New York. The cofferdam involved double walls of long piles, connected by pile diaphragms, filled with earth and rip-rapped. Several novel and unusual features marked the work. The information in this article is due to "Contracting."

The municipal pier at Forty-sixth Street and North River, New York, was designed and constructed to provide for the largest ocean steamships and is 1,050 feet long and 150 feet wide. It is perpendicular to the bulkhead line and the shore end has been constructed and rock excavation for the adjacent slips has been executed in a cofferdam of extraordinarily large dimensions.

Design of Cofferdam

The cofferdam which enclosed three sides of a rectangle about 250 feet wide and 800 feet long, had one end built adjacent to an existing pier. The other end and the long side were made with double walls of interlocking steel sheet piles, from 16 to 22 feet apart connected by transverse rows of interlocked piles 24 feet apart forming pockets filled with dredged material and braced by rip-rap embankment sufficient to give it independent stability without bracing against the unbalanced hydrostatic pressure.

The filled cofferdam was L-shape in plan, about 1,100 feet long and composed of 42 approximately rectangular pockets and two circular ones 55 feet in diameter, which were necessary to clear an existing pier. The outer and inner walls of the pockets were curved and were braced apart by a horizontal 15-in., 40-lb. channel on top of each transverse wall.

At each of the intersections between the curved outer walls and the transverse walls a special pile was provided to connect the adjacent piles in the three intersecting planes. This pile was made with three half-piles riveted together with three oblique angles forming a single heavy pile with Y-shape cross section, as shown in an accompanying illustration.

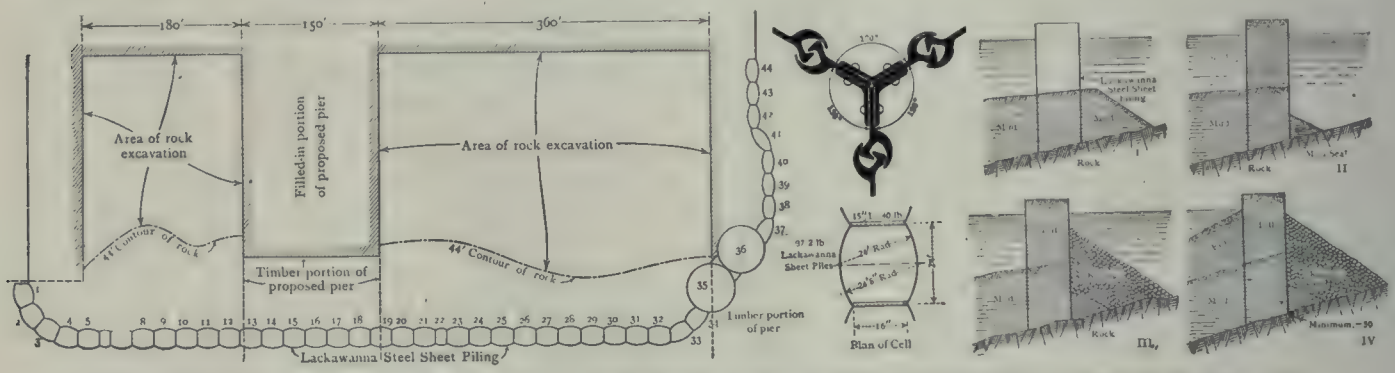
About 3,500 tons of 37-lb. Lackawanna steel sheet piles from 50 to 73 feet in length were required and were driven to rock with a penetration of 34 feet through mud and clay. It was computed that a tensile stress of 4,640 lbs. per linear inch was developed in the joints by the maximum unbalanced head of 58 ft. and thus produced positive contact making watertight joints.

Sequence of Operations

Wooden templates were fastened to four location piles driven in each pocket, the sheet piles were assembled around the templates and driven, the mud and clay on the inside of the cofferdam was dredged and deposited in the pockets, a large amount of rip-rap was dumped against the interior face of the cofferdam, and fill was dumped against the exterior face.

Care was taken to deposit some of the exterior fill before all of the interior rip-rap was placed and caution was observed both in excavating and filling to maintain the stability of the dam and not allow a great unbalanced pressure on either side.

Construction openings were left in the cofferdam for the passage of barges. These openings were subsequently closed and the dam unwatered by pumping. Finally, after construction below water level was completed, water was again admitted, the sheet piles were pulled and the rip-rap and fill were dredged out to the required depth. The unwatering required the pumping of an estimated quantity of 55,000,000 gals. of water to a maximum head of 51 feet.



A large steel pile cofferdam, showing plan of scheme on the left and the sequence of filling and rip-rapping operations on the right. The centre illustrations show a plan of one cell and a cross-section of the specially fabricated pile.

On the north side of the cofferdam a single line of sheet piles 200 feet long was driven against the face of an existing cofferdam and anchored by horizontal 3-inch steel rods engaging the tops of the piles above low water level. One end of each rod had a nut and washer bearing inside the cofferdam on a steel ranger made of two 15-inch, 40-lb. horizontal channels and the other end had similar bearing on a horizontal chock timber engaging two anchor piles driven in the crib pier..

Assembling the Piles

Construction of the cofferdam was commenced by driving four wooden piles in the interior of every cofferdam pocket and attaching to them the wooden templates around which the steel piles were driven. About 3,000 12¾ x ⅜-in., 35-lb. Lackawanna straight-web steel sheet piles from 50 to 73 feet in length were delivered by scows and unloaded and handled at the site by two lighters with 100-ft. trussed booms with a capacity of about five tons. These booms assembled the piles for each pocket, beginning at one of the two front corners of the preceding pocket and working

around to make the closure at the middle of the diaphragm where the structure had sufficient pliability to spring in either direction and to allow for the entrance of the last pile, which, of course, would draw the adjacent piles together as required as it was driven.

On account of the great length of the piles and the penetration about 34 ft. maximum, it was a difficult matter to engage the flanges for the construction joint as each successive pile was placed. The piles were guided by a man who climbed to the top of the last pile on a light ladder, hooked to it, and placed on top of the pile a short temporary sleeve formed by a section of standard pile fitted with clamps which centered and held it on the pile.

The interlock of the projecting sleeve flange was removed so as to leave this flange open and permit the suspended pile to be set in engagement with the side of the projecting flange and thus automatically align itself so that when dropped after entering the closed flange of the pile already in position, it descended readily until it struck the bottom of the river. If it failed to penetrate the mud sufficiently to bring the top of the pile within 25 feet of the surface of the water, it was churned up and down until it descended to this level or if necessary was driven a short distance with a steam hammer so as to bring the top to a low enough elevation to permit the engagement with the next pile with the 100-ft. boom. A force of about five men was required for assembling and ordinarily assembled the 64 piles required for a regular pocket in one eight-hour shift.

Driving the Piles

About half of the piles required for the cofferdam were assembled before driving was commenced. Monarch No. 2, Hamilton, and Arnott steam hammers were installed on lighters, and where no obstructions were encountered each drove from 80 to 130 piles in one eight-hour shift. Considerable delay and irregularity were, however, occasioned by obstructions, of which the worst were two timber cribs encountered at opposite ends of the cofferdam. In these cases heavy driving was required to crush the timber and force down the piles to solid rock where all of them were brought up.

At the commencement of the driving for each pocket, the hammer was arranged to engage three piles at once, and after driving them a few feet engaged the next three piles, and so on, working around and around the pocket. When the driving became too hard, the hammer was changed to engage two piles at once, which continued until finally the driving was completed by driving a single pile at once, until the sound indicated to the inspector that the pile had reached rock bottom.

The Hammer Guide

At first considerable difficulty was experienced in maintaining the hammer in alignment with the pile while suspended from the derrick without the guidance of any ways. This was later obviated by an ingenious appliance which consisted of extension guides screw-bolted to the body of the hammer and projecting below it so as to securely engage the pile and hold the hammer in line with it and firmly fixed on top of the pile. The ends of the guide were provided with bearing blocks, fitted to the curved flanges of the pile so as to hold it very firmly in position without transverse movement. The bearing blocks were arranged so that with the hammer turned in one direction they would take bearing on three piles and allow them to be driven in a group or when turned in the opposite direction would engage the flanges of two piles and allow them to be driven together. When a single pile was driven alone a follower was used on account of the width of the hammer being greater than that of a single pile.

This device had the advantage of keeping the hammer always in position to deliver its blow axially and drive the pile straight. It was useful as a support for the hammer, enabling it to be seated on top of a pile and left there, which was more expeditious and satisfactory than releasing it from the derrick and laying it down on the deck of the lighter. It also made it possible for one derrick boom to operate two steam hammers, setting one on top of the pile and leaving it securely supported there by its guide while it set the other steam hammer on another pile.

Filling the Pockets

Material adjacent to the pockets was dredged from the interior of the cofferdam by orange peel and clam

Appearance of sheet pile cofferdam pockets. They are being filled with material excavated with clam shell buckets.

shell buckets operated by the lighter, and deposited in the pockets. Most of it was hard clay covered on top with mud and silt. As soon as the dredging was carried to the rock adjacent to the pockets, the tops of the pockets were covered over with a planked platform and a rip-rap fill was commenced on the inshore side of the pocket. This was carried up half way to the top of the cofferdam and an earth fill commenced on the outshore side of the pocket, care being taken to fill the interior of the pockets with additional material set always at a little higher level than the rip-rap or the exterior embankment. This fill, together with the exterior fill, was delivered by teams from subway excavations, cellar excavations ,and other sources.

In one case where the filling of a pocket was carried up too far above the outside fill, the resulting pressure became too strong and burst the pocket, causing a considerable separation of the piles. A number of these piles were pulled, the walls of the pocket were drawn together by turnbuckle rods, and new piles re-driven restoring the continuity of the walls.

Unwatering the Cofferdam

It was considered advisable to reduce the water level in the cofferdam slowly and the pumping was in-

termittent to give opportunity for the cofferdam to adjust itself at intervals to the heavy pressure. A 10-in. Morris centrifugal steam pump with a capacity of 250 gallons per minute was mounted on skids near the middle of the long side of the cofferdam and was lowered down the rip-rap slope by a tackle as it reduced the head from 6 to 7 inches daily.

A 40 x 40-ft. raft built up of cross layers of 16 x 16-in. Oregon fir was constructed, and on it were installed two 6-in. Alberger pumps of a capacity of 1,000 gallons per minute, one 4-in. Alberger pump of a capacity of 450 gallons per minute, and a 10-in. Worthington pump with a capacity of 4,000 gallons per minute, which, with the centrifugal pump completed the unwatering to an elevation 35 feet below low tide. Below this elevation a sump was provided that was drained by the centrifugal pump running in the day shift and one of the 6-inch pumps running at night.

Leaks Under the Sheet Piles

In pockets 6 and 22, sluice gates about 8 feet wide and 6 feet high were provided and were left open during the construction of the cofferdam. When the cofferdam was completed these sluice gates were closed at low tide and unwatering was commenced. As the water was lowered inside the cofferdam several leaks developed at the 44th Street corner and at the 47th Street bulkhead. At 47th Street the bulkhead was enclosed by an outside fill above water level, round piles were driven through the fill to rock, pulled, and the cavities filled with a mixture of unsifted cinders and horse manure well rammed.

Similar treatment was adopted at the other leak where a wooden bulkhead was built and filled with earth and this proving to be insufficient, piles were driven and rammed as before described. Eventually the cofferdam was kept dry by a single electric pump with a capacity greater than the flow and in order to operate it continuously a certain amount of air was admitted in the suction so as to discharge an amount that was carefully adjusted to the amount of flow and the pump was enabled to work automatically all night without attention.

Pulling the Piles

For pulling the piles there have been installed two No. 6 McKiernan-Terry steam hammers arranged for driving upwards, two No. 3 National stock hammers intended for pile driving and fitted for driving upwards, and three No. 1 National pile pullers. Besides these there have also been installed two 50-ton and one 100-ton Lackawanna pile grips operated by the boom derrick or by the lighter derrick.

In addition there has been designed a special pulling grip which consists essentially of a pair of riveted jaws operated by a powerful toggle which is attached to a 10-ton derrick tackle or 30-ton lighter tackle. This grip will take a pull of 60 tons which develops a grip of 115 tons. It has the special advantage of being arranged so that it automatically drops into position and immediately engages the pile and as quickly releases it when the tackle is overhauled. It is also of such dimensions that it can engage a single pile in any position.

Saving Money by Town Planning

AN interesting article appears in the last quarterly bulletin of the Commission of Conservation of Canada on the subject of town planning as an investment for any community. It is argued that instead of looking upon town planning as an expense it would be much nearer the mark if we considered it as a very profitable investment. No doubt there are many towns known to all of us where excessively expensive operations entailed through lack of foresight in street, water, sewage, and other extensions could have been avoided. For the new and rapidly-growing town it seems plain that a proper "plan" of expansion is as necessary as in the building of a house or the laying out of a factory, while for the town that has started wrong there is surely no time like the present to set things right. The following extracts from the article mentioned appear to argue this matter in a very common-sense way:

Can Money Be Saved by Town Planning?

The wrong impression has been given to many people that the preparation of a plan for a city or a town is waste of money and effort because of the probable cost of executing the plan. It never seems to occur to such people that a plan may be prepared for the purpose of reducing municipal expenditure. The object of a plan is to ascertain in advance what are the best things on which to spend the money that is available, not to find out new things on which to spend more money than is spent without a plan. In Canada at present all town planning should be directed to secure greater economy in municipal administration.

Comparison is sometimes made between the planning of a factory and the planning of a city—it being argued that as the one is necessary so is the other. But the city is such a complex thing, and so many of its parts and functions are inter-related and linked up with one another that there is much stronger reason for planning the city than planning a factory or a house. Yet every sane person who builds a factory or a house has a plan prepared for it, while most cities are allowed to grow without plan. There is one comparison between the planning of the factory and the city that is worth noting. The first thing a man does who proposes to build a factory is to decide what amount he has to spend and what facilities and space he requires. He next computes how best to fit in his requirements with his finances. If he is a wise man he calculates on the requirements of the future as well as of the present, and sees that he has a site large enough for reasonable extension in the succeeding 20 or 25 years. He then engages architectural and engineering advice to prepare plans. The architect or engineer is told what money is available, and what provision has to be made. The latter then applies his skill to prepare a set of plans showing how the provision can be made for both immediate and future requirements; next he submits estimates of costs and, where necessary, advice regarding any increased area of site required for future expansion. If the sum immediately available for buildings is $100,000 the preliminary plan and scheme might cost from a few hundred to one or two thousand dollars—but it might have the effect of showing the manufacturer that he should only spend

$80,000 instead of $100,000. The object of the plan being to enable the building to be properly constructed according to the best design, it may as likely show that the manufacturer can accomplish what he wants at less than his rough estimate. Of course, it may equally have the opposite effect. But the point is that the preparation of a plan for a factory or a city does not in itself increase or lessen costs; it merely provides the necessary material and drawings to enable the cost and the proper channels of expenditure to be estimated. It is like preparing a city budget at the beginning of a financial year—the budget, instead of increasing expenditure, enables the city authority to "cut its coat according to its cloth," and may help in securing reductions in expenditure.

If a man were to build a house and pay an architect 2½ per cent. on the cost to prepare plans and estimates and another 2½ per cent. to supervise construction, the architect does not by the act of preparing the plans involve the owner in greater cost than 2½ per cent. of the estimated cost, and for that he may save 10 per cent. on the owners' own estimates in the building if he is a good architect. On the other hand, if no plans were prepared and the work proceeded piecemeal, the owner may spend twice as much for the same house before he completed it.

In many of our cities and towns we are spending money on the wrong things; we are wasting money on non-essentials, and we are creating the beginnings of bad conditions for future generations. By the preparation of a town planning scheme at comparatively small cost we would save much money and wasted effort, and we could avoid mistakes which are caused by want of planning.

These financial advantages are in addition to the social advantages produced by town planning—the improved living conditions, the better facilities for transportation, etc., the higher standards of public health and citizenship, and the greater equality of opportunity. It is sometimes said that the financial side of these problems is unimportant; that the human side is all we need concern ourselves about. That is just as unsound a view as the opposite, which puts all the emphasis on the financial side. The best methods of solving social problems are those which have a sound economic basis. If our method of feeding the hungry results in creating paupers, may not the remedy be as bad as the disease? If our method of city planning destroys individual initiative and helps the waster at the expense of the hard-working citizen, will it not be unsound? The great value of town planning, however, is that while it does not directly solve social problems connected with the land, it is a necessary basis for any proper solution—it is the only method by which they can be solved at reasonable cost to the community on the one hand or without injury to legitimate rights in property on the other hand.

But no town planning scheme, and still less no paper plan unaccompanied by a proper scheme of regulations, can be effective or save money unless it deals with the control of building development and sanitary conditions. Indeed, a wasteful and irrational system of development may result from having a street plan of a town, if land speculation is permitted and there is no regulation regarding sizes of lot and density and character of buildings to be erected. Much of the expensive development seen at Prince Rupert, B.C., for example, would not have had to be incurred if the plan had not been prepared to suit the requirements of the land speculators. A proper town planning scheme for Prince Rupert would have enabled the citizens and the land-owners to have saved large sums of money in development, but it would not have made it so easy to create a "boom" in land values.

An Exhibition of Brick Pavement Construction Given at Annual Convention

One of the most interesting items at the paving conference of the National Paving Brick Manufacturers' Association, held in Paris, Ill., on Oct. 5 and 6, was the demonstration of monolithic brick paving construction in Edgar County. The point chosen for the demonstration was a strip of the Chicago highway adjacent to the city waterworks reservoir. It was not a staged demonstration, but a part of the actual contract for improvement of this road, now being carried out by Allan J. Parrish, under the general supervision of Engineer W. T. Blackburn. The visitors saw not merely the demonstration of each step in the paving process—the laying of the concrete base, the operation of a double template which levelled the concrete and spread a dry mix of mortar, the rapid laying and grouting of the brick surface—but they witnessed a spectacle of structural efficiency that won the admiration of all. Contractor Parrish reported at the end of the day that he had laid 800 yards of pavement, in spite of the unavoidable interference of visitors who pried into every detail of the work and fairly overran the job. The illustration herewith indicates interesting phases in this day's work of laying a piece of brick roadway.

The brick are bedded in green concrete.

Brick are rolled before grouting.

Disinfecting Water with Liquid Chlorine

Conditions that Determine the Point at which the Chemical Should be Introduced to Insure Proper Purification

One of the more recently discovered methods of disinfecting a water supply is by the use of liquid chlorine, which overcomes some of the objections pertaining to the conventional bleaching powder method. The merits of this process have been rapidly recognized, and its application has met with considerable activity. In the design of a liquid chlorine equipment there are certain factors that must be considered, and especially the point at which the chemical must be introduced. These problems are discussed in a paper by Francis F. Longley, in Engineering and Contracting, which is reprinted below:

Liquid chlorine, like its forerunner hypochlorite of calcium, has come into rapid recognition during the past few years for the disinfection of water supplies. Since its first application on a working scale to a municipal supply less than five years ago, several hundred installations have been made throughout the country. The low cost of this treatment compared to any more complete purification such as filtration, its demonstrated efficiency, and the simplicity of its installation and application, have resulted in its rather hasty adoption in many cities. With the newness of the process, the lack of experience in its use, and the scarcity of precise knowledge regarding the chemistry of chlorine when used in this way, there are many considerations now recognized which could not have been taken into account a few years ago, in the design of a liquid chlorine equipment.

The question uppermost when an apparatus was to be purchased seems to have been, "Will it work? Will it deliver the disinfecting agent into the water in a regular, dependable way?" Upon the showing of the first striking experiments on the use of liquid chlorine, it was generally accepted, subject to certain recognized limitations, that the disinfectant would always produce a reduction in numbers of bacteria; and, therefore, while bacterial reduction has been the primary object of this method of treatment, it seems that in many cases this has been left subservient and considerations of physical or engineering convenience have determined the point of application.

It would be interesting now to examine these numerous installations in detail and study the conditions which led to these various points of application. It is not feasible to do this, but a review of some of the conditions now known that are likely to control the location of the point of application may be of interest.

This discussion was intended primarily to relate to the liquid chlorine treatment. In many of their phases the treatments by liquid chlorine and by hypochlorite are so much alike that experience with both of them yields light upon the conditions under discussion; and, so far as the essential points are covered thereby, occasional reference may be made to hypochlorite.

Two Classes of Installations.

For a consideration of this question all installations may be divided into two classes. First, in those installations in which disinfection is the only treatment which the water receives, the location of the point of application will be determined by physical or hydraulic conditions. Second, in the installations in which disinfection is an adjunct to some other more complete treatment, such as filtration, not only physical conditions, but also conditions arising from the proximity or inter-relation of the two forms of treatment, must be considered.

Based on physical conditions existing at the point of application, liquid chlorine equipment may be considered under two heads—first, with the application made as a solution; and, second, with the application made as a gas. These two methods of application give rise to conditions which have an important effect upon the selection of the point of application.

If the chlorine gas is mixed with water before reaching the actual point of application to the supply, the flow of this solution must, of course, follow the laws of hydraulics. The solution of the chlorine in the water is generally accomplished in an absorption tower or tank of some kind located at or about the elevation of the chlorine tanks and other apparatus. The absorption tower is in most cases open to the air, and the flow therefrom into the supply is commonly by gravity. There are a few installations in which this solution is pumped into the supply, but the pumping of such a liquid is a bothersome procedure, and is usually avoided if possible.

If the solution is to be delivered into the supply without pumping, the absorption tower must stand near enough and high enough above the hydraulic gradient of the supply into which it is delivered to afford free gravity flow. This arrangement can in most cases be conveniently secured by putting the solution into the suction of a pump or into an open suction well or conduit. It does not in general permit the delivery into a closed conduit or pipe under pressure, unless some means is provided for pumping the solution against that pressure.

This is, perhaps, the most common point of application, and it has the advantages of convenience and of thorough agitation and mixing of the treated supply as it passes through the pumps.

Corrosion Due to Chlorine.

There has frequently been some concern felt over the question of corrosion in the pump, due to the introduction of a corrosive substance like chlorine into the water just before it enters the pumps. When the use of hypochlorite was comparatively new, there were a number of cases noted of corrosion of pumps, but they were the exception rather than the rule, and may have been due to excessive application with imperfect apparatus, or some other accidental cause. Experience through several years past with liquid chlorine indicates that there is no real danger from this. The mechanical absorption of the gas by the water seems to be so prompt and so complete that it does not have an opportunity to act upon the metallic surfaces of the pump, or pipes.

There are a few installations in which the liquid chlorine is applied, in the form of a chlorine solution, on the discharge side of pressure filters. This is accomplished by utilizing the drop in pressure through the filters. The supply of water for the absorption tower is taken from the main supplying the filters. The absorption tower, instead of being open to atmospheric pressure, as is usual, is completely closed, and under

substantially the pressure of the supply main. A head practically equal to the loss of head through the filters is then available to deliver the chlorine solution from the absorption tower into the pressure main on the discharge side of the filters.

There is a limitation to this fixed by the minimum pressure to which the chlorine tanks can work. It is perhaps sufficient to state that the application could not be made as above described if the pressure prevailing in the discharge main from the filters much exceeded 40 or 50 pounds.

Introduction of Chlorine as a Gas.

If the application of chlorine is made to the water supply as a gas, there is no point in the apparatus at which the pressure of the gas drops to atmospheric pressure. The tank pressure as reduced in a pre-determined way by pressure reducing valves is available to deliver the gas into the supply. The tank pressure must not be permitted to fall, due to chilling from too rapid vaporization, below about 54 pounds, or troubles result from the refrigerating effect produced. With some allowance for loss of pressure through the apparatus, it is therefore possible to deliver the gas into the supply from this tank pressure against a considerable water pressure. A water pressure of 35 pounds is commonly stated as the limit against which a gas may be thus applied, but cases are on record of application against pressures somewhat higher than this.

These cases, however, may require that artificial heat be applied at times, in order to keep the tank pressure at a point high enough to accomplish the delivery as stated.

With this limitation the chlorine may be applied as a gas into a water main under some pressure. It may be applied at an elevation considerably higher than the elevation of the tanks and the control apparatus. It may be conveyed through pipe a distance probably considerably greater than the distance to which chlorine solution could be carried. There is, therefore, much greater latitude in the selection of the point of application when the chlorine is to be applied as a gas than as a solution.

The condition of distance is sometimes met by separating the absorption tower from the tanks and measuring apparatus. The chlorine can then be carried as a gas to any reasonable distance and discharged into the absorption tower, which, in turn, can be so located as to facilitate the discharge of the solution into the supply.

Amount of Supply Affects Application.

Another condition may be mentioned here which may affect the type of apparatus and therefore the point of application in many small supplies. The chlorine when delivered into the supply as a gas is measured through an orifice, when a difference in pressure is maintained on the two sides of the orifice by means of pressure control valves. The size of an orifice which will deliver, say, 25 pounds of gas in 24 hours, under the head commonly used in this apparatus, is very small. This is equivalent to about 0.3 parts per million of chlorine in a ten-million gallon supply. If the total quantity of gas supplied in a day is much less than this, the orifice becomes so small that it becomes increasingly more difficult to keep it clean and deilvering at a uniform rate as an orifice should. The size of the orifice which will deliver 1 pound of gas in 24 hours is so small that it will no more than permit the entrance of the point of a fine needle. For a quantity of gas as small or smaller than this some other device must be used for its measurement. Orifice meters are now in use delivering quantities down to a minimum of about 1 pound per 24 hours in the gaseous state, but for total daily quantities smaller than that, the devices in use involve the formation of a solution of the gas. The conditions and limitations described above for the application of a chlorine solution to the supply, therefore, must apply to any supplies which require such small quantities of chlorine as were just mentioned.

When the chlorine is applied in a gaseous state it is commonly distributed into the water through a porous diffuser of some kind, which delivers it as a mass of extremely small bubbles, of chlorine. Chlorine gas bubbles thus set free in water tend to rise to a fairly constant velocity of about 24 feet per minute. It has been found in practice that the bubbles arising from the diffusers commonly used become completely absorbed by the water before they have risen about 4 feet on the average. This will vary somewhat with the quantity of gas set free at the diffuser, but 4 feet is commonly looked upon as sufficient depth of submergence for an apparatus delivering normal quantities of gas. For this type of apparatus a point of application must, therefore, be found which will have at all times a suitable depth of water.

Ordinarily no difficulty is encountered in this matter. It occasionally happens, however, that a fluctuating water level, at the point of application may at times reduce the depth of water over the diffuser below the limit mentioned. A proposal to apply the chlorine as a gas under these conditions would contain some elements of risk, involving possible loss of gas, the escape into the air of corrosive chlorine, and a reduction in efficiency of the treatment. It might at times be difficult to find an alternative location readily accessible where the conditions of depth of water would be at all times suitable for the application of chlorine as a gas. Under such conditions, the choice would be presented of applying the chlorine as a solution where a small limit of depth was immaterial, or of seeking a more perfect but perhaps more inaccessible location for the application of the chlorine as a gas.

Where disinfection by liquid chlorine is the only form of treatment used, the difference in bacterial efficiency, at different possible points of application, is likely to be unimportant. Where used as an adjunct to filtration, however, the efficiency may be quite different for different points of application.

The use of liquid chlorine is sometimes claimed to, but cannot be depended upon, to reduce in any degree any of the other objectionable contents of a water supply. The reduction of bacteria was the primary reason for the development of this process, and, therefore, bacterial efficiency may be considered the factor of foremost importance.

Application After Filtration.

Where disinfection is used as an adjunct to filtration the ideal point of application is in general after filtration. The efficiency of liquid chlorine as a disinfectant is influenced by the presence of color and turbidity and by other substances dissolved in the water. A water that contains considerable quantities of turbidity or color requires a much larger dose to produce a given bacterial removal. The quantity of liquid chlorine required to produce a satisfactory final result is, therefore, must less if the application is made after the turbidity of color is removed by the filtration treatment. This may be considered one of the phases of an ideal treatment.

It sometimes happens that the application in the

filtered water results in objectionable tastes or odors. Waters differ in their susceptibility to trouble of this sort. With some waters the dose of chlorine that is required to give the desired bacterial results is also enough to leave a taste. With others there is a safe margin between these two limits.

When the former conditions prevail, it is desirable to apply the chlorine after filtration, but before the water goes to the filtered water reservoir, as storage is an important factor in the dissipation of any tastes or odors that may result from the treatment.

This consideration is less important where tastes and odors give no trouble. In a great many plants now in service the application is at a point beyond which there is no detention except in the mains before the water reaches the consumer. Conditions are not constant, however, and there may be times with most supplies when tastes and odors may be detected. It is desirable, therefore, in every case in which it can be arranged to apply the chlorine to the water before it goes to the filtered water reservoir.

Overcoming Prejudice.

In the early days of disinfection of public water supplies there was in many places a prejudice against the application of a chemical of any sort, especially of a chemical with the supposed highly corrosive properties of chlorine or hypochlorite, to the water after it had passed through the filters. A filter operating efficiently was considered to be as near the acme of perfection as could reasonably be attained.

This prejudice arose from the fear that objectionable tastes and odors might result if the water were treated with a disinfectant just before being delivered to the consumer, and also the fear regarding turbidity that might be contributed by the sludge when hypochlorite was used. It is true that tastes and odors have sometimes been conspicuous, but longer experience and broader acquaintance with liquid chlorine treatment has resulted in a great reduction in difficulties of this kind, and this prejudice has been quite overcome. Now the filter effluent is considered quite generally the ideal point of application for the chlorine.

In a number of cases the application of a disinfectant has been made just before the water was applied to sand filters. In some of these cases the results have been disastrous to the bacterial efficiency of the filters. The reasons for the application at this point are not now clear, but these cases occurred several years ago, when the treatment was new, and those who chose the point of application could hardly have foreseen what the results would be.

Application Before Filtration Unsatisfactory.

The application resulted at first in a very good reduction in numbers of bacteria. This was followed within a short time by a large increase in the bacteria in the effluent, the numbers there being even much greater than the numbers in the raw water. This condition of affairs persisted for some time until the cause of the trouble was perceived and the application of disinfectant discontinued at that point. The restoration of a normal bacterial efficiency to the filters took some time, and the subsequent application of the disinfectant to the water after filtration produced the desired results. The reason for this appears to have been the destruction, either partial or complete, of bacterial life in the schumtz-decke on the filter, with its subsequent decomposition which afforded food material for the prolific growth of organisms. The removal of this purifying agency and the presence of this food material encouraged the appearance of large numbers of bacteria in the effluent.

This trouble arose from the fact that the disinfectant was still in an active state when it reached the surface of the sand. It is commonly considered, with good supporting evidence, that the chlorine acts very promptly in reducing the bacteria after it is applied to the water. There are certain lines of evidence, however, such as the above, which indicate that all the reactions resulting from the addition of chlorine to the water are not complete for some little time after its application. There is no evidence at hand to show how long this time is. There are a number of plants, however, in which the application of a disinfectant is made as the water enters a coagulating or settling basin, just preceding filtration. No deterioration of the filter as a result of this application has been recorded, which leads to the belief that in these particular cases the time of storage after the disinfection treatment and before the water reaches the filters has been great enough to permit the completion of all the reactions that result from the addition of the disinfectant.

In a number of cases liquid chlorine is applied to a supply just before it is pumped into pressure filters. With filters of this type primary dependence is not placed for the bacterial purification upon the presence of a living organic schmutz-decke. It may be, therefore, that the above remarks do not apply to this condition, but there is room for suspicion that the bacterial results following the treatment arranged in this way may not be all that they should be.

Some claims have been made that a saving could be effected in the quantity of alum required with a mechanical filter if liquid chlorine were applied before filtration. The study of this question has been rather limited. There are a few ardent advocates of this belief, and it is possible that in some cases a saving may have been accomplished. So far as it is true, this condition also will affect the point of application.

The Question of Economy.

Economy is many times a consideration in the location of a liquid chlorine equipment. The apparatus must be housed. A pumping station or gate house or other building is usually located conveniently, but it sometimes happens that this location will not facilitate the application in the ideal way. When this condition of affairs exists, it has frequently happened that rather than build a new building especially to house the liquid chlorine equipment at the ideal point, it has been located in an existing structure in the hope that the results of the treatment will be just as good at that point.

The question of availability of a supply of water for the solution of the chlorine often influences the point of application. The convenience of the determination of the rate of flow in the main, or conduit, to which the chlorine is to be applied, in order properly to adjust the dose, is sometimes an important factor in fixing this point.

It is unfortunate that data are not more generally available to show definitely the relative advantages or disadvantages of these points, especially with reference to the bacterial efficiency which results, and to the quantity of disinfectant that has to be applied. Efforts that the writer made a year or so ago to get comprehensive information along these lines indicated only that systematic observations are not commonly taken to determine the efficiency and the economy of this treatment.

Swarthmore College is running its engineering department like an industrial organization.

The City Manager—A New Opportunity for Engineers

By Gaylord C. Cummin*

It is with a great deal of pleasure that I bring to you a new thought in public affairs which should interest you as citizens, and should be of peculiar interest to you as members of this body, because it has received its best expression to date through engineers, and promises in the future a wonderful opportunity for engineers to assume in the public mind the position to which they are justly entitled. Engineers have been entirely too content in the past to take credit only for their technical achievements, and leave the glories of dreams that come true, of wonders of administrative effort, of wise and judicial counsel which have made our country great, to rest on the brow of those who were in positions of prominence, and to whom they do not rightfully belong.

A real engineer is much more than a man who juggles with figures and formulae, and makes queer designs on a drawing board. A real engineer must know for what purpose he plans both economically and physically; he must know how his plans can become financially possible; in short, he must be an administrator in order to make his designs accomplished facts, and to build efficiently and well. Very many engineers can do all these things and yet are content with being employed only for their technical knowledge, whereas such qualifications as those above, equip them to take a leading position for public service in the community where they live.

The Engineer's Place in City Administration.

In this field of public service the engineer has always taken a much more subordinate position than that to which he was entitled. Seventy-five per cent. of the problems which occur in the administration of our cities are engineering problems pure and simple, and the rest of them are such that an engineer is at least as well fitted to handle as a man trained along any other line, they being largely problems of organization and social justice. The vital municipal problems are pure water and plenty of it, adequate sewers, clean streets, proper buildings, adequate transportation facilities, efficient police and fire protection, proper education and recreational facilities, etc.—these things to be secured with the smallest expenditure of money possible to get the needed results.

Most of these are engineering problems, and can be best handled by engineers; hence our opportunity once the citizens can be educated to the point where the administrative part of the government is judged on its ability as such, political questions being relegated to the legislative branch where they belong.

Municipal government on this continent has been unfortunate in both its genesis and its evolution. It is clear that advanced ideas and ideals of government are most likely to develop in comparatively small and coherent communities. In Europe the nations developed from cities, and national government from city government. Due to this development, the cities of Germany and England have had a large measure of freedom and abundant opportunity to develop what governmental forms were best suited to their peculiar needs. The result has been that the cities have been many years ahead of the nations of which they are a part, in government and in effectiveness with which they render service to their people. In this country at the time our national government was formed we had no cities, properly speaking, and the simplest and crudest of methods sufficed to handle the municipal problems of the time. As the cities outgrew the possibilities of the old town-meeting and our cities became large and their problems complex, a change had to be made, and our national form of government was modified and used by the city, and without any reference to the reasons for certain provisions in our constitution. The cities accepted both the fit and the unfit, even to the two houses in the legislative branch. To further complicate matters, in many cases a large number of the administrative heads were made elective, whereas in our national government, as outlined by the constitution, no administrative officer was supposed to be elected, the president being selected and appointed by a deliberate body—the electoral college. This is the basis of the so-called "federal form" of municipal government.

Federal Form of Municipal Government.

It consists, briefly, of a legislative branch of one or two houses, elected from districts called wards, an elective administrative officer called the mayor, and elected administrative department heads ad infinitum. This form is distinguished by a system of checks and balances to insure honesty and prevent efficiency; by almost guaranteeing that no administrative head shall be selected for his fitness for his particular position, and by insuring that no man knows for what he is responsible, or to whom he is responsible. Furthermore, because the legislative branch and administrative officers are each severally responsible to the people, there is no teamwork in the organization, and the real good of the city is sacrificed to petty political quarrels. The speaker was an officer in a government of this kind where the council was of one party and the administration was of another. Everything good started by the council was blocked by the administration and vice versa, the city very naturally suffering.

However, it is admitted that the federal form is not and never has been a success, so I shall not elaborate upon its shortcomings. Suffice it to say that it violates every fundamental of efficient organization.

Commission Government.

The so-called "commission" form, as exemplified in Galveston and Des Moines, is a decided improvement in some ways, but falls far short of the ideal. This plan consists, in brief, of a small council elected at large which constitutes the legislative body, each member being made the administrative head of one of the city departments. This is an improvement, because ward lines are eliminated and the organization somewhat simplified, but still has a lack of centralized responsibility, places men in technical positions who are not specially qualified for them, and is positively vicious in making a man's success as a commissioner depend upon the success of his particular department and not the success of the city as a whole. This will result in time in a majority of the commision dividing the bulk of the funds among their departments, because in this way they can show more results, and the minority taking what is left, although their depart-

*City Manager, Jackson, Mich., before the Western Society of Engineers.

ments may be the most important. Under the commission form there is no fundamental improvement in organization, the improved results coming from an awakened public interest in municipal affairs shown by the fact that any change in government was made.

Now before we go further let us state a few fundamental facts that are often ignored in considering governmental affairs.

It is impossible to legislate honesty. This is attempted in our famous principle of "checks and balances," which does not prevent dishonesty, but does prevent efficiency.

It is impossible to legislate efficiency, and no laws or charters will ever insure it.

The legislative branch of government is the real governing body, the policy-forming body, while the administrative branch merely carries out these policies, and any attempt to mix the functions as here laid down will result in disaster.

A City Is a Business Corporation.

A city is a business corporation, with citizens as stockholders who expect dividends of service. A city differs from other business corporations only in that, fortunately, its income does not depend upon its efficiency.

Now, considering the city as a business proposition, let us analyze the type of organization as set forth in the federal and commission forms in the light of this viewpoint.

Would any of you care to invest your money in a business whose stock was widely held, and where the stockholders elected a board of directors, a president, a general manager, a superintendent, a chief chemist, a chief engineer, etc., none of whom were to be responsible to each other and whose fitness for technical administrative positions was subordinated to their being "good fellows," because the individual stockholder would be in no position to properly inform himself as to those technical qualifications?

Would you care to invest your money in a business where the stock was widely held and where the stockholders, subject to the same limitations as before, should elect a board of directors each one of which would ex-officio become general manager, auditor, chief engineer, etc.?

If you did care to, your families would certainly be justified in worrying about your sanity, because such corporations would certainly end very quickly in a receiver's hands, and yet you are investing for your health, safety, comfort, and welfare in just such corporations.

Commission-Manager Government.

The commission-manager form of city government is an exact parallel to the form which our experience has taught is the only one under which satisfactory results can be obtained in business. It is not presented as bringing about a municipal millennium. Nor is it new in principle—only in application. There are no mysterious or wonderworking powers concealed within it. It is simply the application to city government of the only methods by which we have been able to manage business corporations efficiently. It does not insure efficient government. No charter form can do that, but it is the only form under which efficient government can be expected, judging by our experience in business.

It consists, briefly, of a small council, elected at large, corresponding to a board of directors, and whose duties are purely legislative. This body appoints the chief administrative officer, the city manager, who corresponds to the general manager of a corporation, and who has complete control of the whole administrative machinery. He holds office at the pleasure of the commission, and is responsible to it for his acts. Responsibility is absolutely centralized on the commission and through them on the manager.

There is never any chance to dodge an issue by placing the blame on somebody else. If anything goes wrong in the administrative branch the manager can be held responsible, and the people can call their representatives to strict account for mistakes and inefficiency in the administrative branch, because of the commission's power to remove at will the city manager.

Elimination of Party Politics.

What has been the result of this mode of operation? In the city manager cities party politics has been entirely eliminated from the administrative side of city affairs. In our city the commission do not know my politics, and I do not know those of a single one of my subordinates, and, furthermore, I do not care. A man's beliefs on the tariff or our Mexican policy have no bearing upon his efficiency as a waterworks superintendent. What possible difference does it make whether the dog-catcher is a Democrat, Republican, or Socialist, providing he is a good dog-catcher?

We have teamwork in our organization, and nothing can be accomplished without that. We must have it, because the department head that refuses to work in harmony with the manager will soon be looking for another job, and the manager who will not work with his commission will not last very long.

Our department heads are selected for special fitness for the positions which they hold, and not because they are "good fellows." The manager must select on this basis because an inefficient department head will reflect on the manager and he cannot evade his responsibility.

Responsibility is centralized from top to bottom, and this is the best incentive to honesty and efficiency that has yet been devised.

What This System Has Accomplished.

Our accomplishments in Jackson after one year's operation are as follows: We have taken city employes out of politics, reorganized the police force, and are developing it on the basis of a survey of its needs made by an expert in police organization; are using a trained social worker as a policewoman to handle the young girl problem; have installed a modern system of double accounting, with controlling accounts; have passed our annual budget, based on a uniform classification of expenditure by kind; have installed careful cost accounting on city construction work, separated the sinking fund from the general fund and put it to work, accumulated a sinking fund balance of $45,000 where the old government had none, centralized the water department under a competent superintendent, read meters quarterly instead of semi-annually, presented bills to consumers as does any like public utility. We have divided the city into three sections, so that the same force of meter readers can be employed constantly, the bills for one section being due each month; have made a waste water survey; and are reinforcing the much neglected distribution system on a rational basis. We make purchases for the city through a purchasing agent and take all cash discounts, these amounting to enough to pay all the expenses of the purchasing agent and his office. We have replaced $380,000 on the tax rolls that was formerly exempt without legal reason; and made all assessments both for taxes and special purposes under

one man on full time, instead of nine elected assessors on part time, at a saving in cost and increase in efficiency. We are saving $4,000 per year by paying the treasurer a salary instead of fees. We are making a complete study of the very inadequate sewer system, based on a topographic map now being made on a scale of 1-inch equals 200 feet and with a 1-foot contour interval, and are contemplating a complete redesign on modern lines, with a comprehensive plan for relief as well as for future extensions. We have installed a modern boulevard lighting system, under a peculiarly advantageous contract; installed patrol system of repair on graveled streets; are giving efficient food and milk inspection; have replaced a part-time health officer with a competent physician on full time, made over twice as many inspections with one sanitary inspector as were made formerly by two; have centralized privately supported public nurses, the organized charities of the city, the city poor relief and humane officer under a trained social worker so that there is no duplication of work; we have made the city hospital and training school for nurses a model in so far as the buildings will allow; will construct this year a modern hospital building to cost $150,000; have equipped and opened a tuberculosis hospital; equipped and opened two branch libraries; started the improvements on a new 520-acre park; are motorizing the fire department on a plan that will make it unnecessary to purchase any new horses or sell any horses at the height of their usefulness; are completing a building code; are giving efficient electrical inspection, and have inaugurated inspection of weights and measures.

Financial Benefits.

We have reduced the net debt over $50,000, paid off a floating indebtedness of over $20,000, given over $15,000 services not contemplated, and ended the fiscal year with a cash balance of nearly $10,000 and liquid accounts receivable of $37,000, and have not raised the tax rate. Furthermore, although theoretically we operate for six months on borrowed money, and heretofore money was borrowed seven to eight months before receipt of taxes, we are now in our fifth month and have not borrowed a cent.

Any city can get as good results by using a few business methods and a little business sense. I am not detailing these things for any other purpose than to show the possibilities of this mode of operation, and to give you gentlemen a slight idea of the diversity of questions that come before a city manager. I have the administration of such unusual things as a public library, two hospitals, two cemeteries, and a small summer resort.

Engineers Qualified for City Managers.

The special point of interest to engineers is that all the larger cities operating under this form of government have engineers as city managers, and they are making good. In fact, in many cases none but engineers are being considered. A city manager must be primarily an executive, but, given that qualification, the engineer is preferred over men of other professions, because such a large percentage of the problems which arise are engineering problems.

There are now over eighty cities and towns operating under this plan, and the number is just about doubling each year. Where are we to find the city managers for these openings? Most of them will be drawn from the engineering profession direct, for a good many years, but finally we hope that the plan will spread so that a man can take it up as a profession, start as manager of a small town after having received an engineering education, and be promoted to larger ones if he makes good.

In this field there will be in the near future many openings for engineers, well paid permanent positions, where the engineer can at last take his proper place in public service, to the lasting benefit of both engineer and citizen.

Repairing Pavement Cuts Cheaply

Pavement cuts are repaired at an average cost of 20c per square foot by the Ottawa Gas Company, of Ottawa, Ont. At the recent annual convention of the Canadian Gas Association the methods were described by Mr. P. S. Lamb, superintendent of the service department, as follows:

When cutting pavement, we first take off the asphalt, lay it to one side, then take out the concrete, and lay it out of the way. When the work of repairing has been finished the hole is filled up again, tamping everything back as before. We then mix the old concrete with about two bags of cement, adding a little sand.

After this has been put back we mix what is left of the two bags of cement with sand, mixing it up thoroughly, about 3 to 1, and place it on the top of the concrete which we have put back. Then we put on the asphalt, tamping it level, by using under the tamper a piece of plank long enough to catch the edge of the firm pavement. This piece of board keeps it to the exact level, and all cement that comes up around the edge of the cut is then leveled off, which completes the work. This is protected for 24 hours by a trestle, after which it takes a keen eye to detect the cut. The cost of this work would be as follows:

2 bags of cement at 60c each	$1.20
2 men for one hour at 30c per hour each	.60
Total.....	$1.80

As the average cut is about 1 square yard, this would be exactly 20 cents per square foot.

The Chain Belt Company, of Milwaukee, Wis., has appointed Mr. C. F. Messinger manager of their concrete mixer department. Mr. Messinger has for years managed the advertising department, and is thoroughly acquainted with the mixer business. He will take charge at once, and will augment the service feature which has always accompanied chain belt mixers. Mr. Messinger is a graduate of the Sheffield Scientific School of Yale University, and is well known by mixer men throughout the country.

The Commission of Conservation of Canada have issued a report of the Conference on Civic Improvement of the Civic Improvement League of Canada, which was held in Ottawa earlier in the present year. This conference was held in co-operation with the Commission of Conservation.

The quarterly bulletin issued under the direction of the Commission of Conservation of Canada, entitled "Conservation of Life," just to hand, contains a number of interesting articles dealing with public health, housing, and town planning.

Mr. J. Gravel, consulting engineer, Montreal, has received instructions to prepare plans for a mechanical filtration plant for Chambly Basin, P.Q.

A Road Survey Planned

The Portland Cement Association is planning to undertake some time between October 15 and November 15, a comprehensive survey of all concrete roads in the United States, the object being to determine their condition and to confer with local road authorities everywhere as to maintenance or any similar attention that such roads may need. It is intended to so record the findings of this survey that there will be in existence a real history of the concrete roads at present in the United States.

Lieut.-Col. C. H. Mitchell Moves Up Again

Canadians everywhere must be highly gratified over the announcement, just to hand, that Lieut.-Col. Charles H. Mitchell has been promoted from the general staff of the Canadian corps in France to be first general staff officer of the general staff of the British Second Army. On the Canadian staff Col. Mitchell has done some very notable work, chiefly in charge of Intelligence, and won considerable recognition for the systematization of Intelligence for the conduct of entrenched warfare. The Canadian Intelligence system has become the model of the British and French armies.

Col. Mitchell left Canada in September, 1914, on the general staff of the first Canadian division, and won his first laurels in the second battle of Ypres, his special services being recognized by his being invested with the Croix d'Officier Legion of Honor by the President of France. In August, 1915, he was promoted to first staff officer of the First Division, and in September, 1915, was made chief Intelligence officer of the general staff of the Canadian Corps, which embraced the two Canadian divisions then in France. In June, 1916, Col. Mitchell was honored with the Distinguished Service Order for his special Intelligence operations. He has been "mentioned" several time.

Lieut.-Col. C. H. Mitchell.

The move-up from the Corps to the Army will give Col. Mitchell considerably greater scope, more especially as the second army, of which the Canadians have until lately been a part, is stationed in the Ypres district, and it is said by several authorities that he is the best informed officer of the condition on the Ypres front.

Col. Mitchell is a member of the firm of C. H. & P. H. Mitchell, Toronto, and is a well-known consulting engineer. Always a military enthusiast, he has progressed through infantry, cavalry, corps of guides, and latterly trained in the staff college, with always the Intelligence service as his goal. Peculiarly, as Col. Mitchell has often said, this service is analogous to the general duties of a consulting engineer. The reports on the situation, the scheme of action, the plans, the cost, the supervision during progress—all have their counterparts in the handling of the enemy.

Trade Publications

Heaters—Catalogue 230 by the B. F. Sturtevant Company, describing various classes of heaters and heating.

Multivane fans—Bulletin 228 by the B. F. Sturtevant Company, Boston, describing their design No. 3, multivane volume fan.

Economizers—Bulletin 222 by the B. F. Sturtevant Company, describing the use of economizers in the power plants of paper mills.

Electric Fans—Catalogue No. 240 by the B. F. Sturtevant Company, Boston, describing, with illustrations, fans for practically every purpose.

Portland Cement—The Portland Cement Association, 111 West Washington Street, Chicago, have issued interesting pamphlets on the following topics: (a) Concreting in cold weather; (b) That alley of yours; (c) Concrete houses and why to build them.

Mainly Constructional

East and West—From Coast to Coast

The Pacific Steel Company, Limited, had been incorporated with a capital of $100,000, head office at Vancouver.

Canadian Metals & Equipment Company, Limited, has been incorporated with a capital of $25,000, head office at Vancouver.

Building permits in Chatham, Ont., for the first nine months of this year aggregate $257,074, an increase of $88,260 over the same period in 1915.

Building Inspector McKenzie, of Vancouver, B.C., has been engaged in the revision of the city building by-laws in order to bring them up to date.

R. A. Kemp, Limited, has been incorporated with a capital of $40,000, head office at Ottawa. One branch of the company's business will be the building trade.

The building permits issued at Port Arthur, Ont., in September, number 20 and total $93,035, as compared with 12 permits in the same month last year, at a value of $2,220.

The total value of the building permits issued in the city of Quebec during the first nine months of this year is $364,250, as compared with $264,800 during the same period last year.

Some 200 delegates, including educationists, employers of labor, sociologists and experts on housing and sanitation,

attended the fifth conference of the National Housing Association at Providence, R.I., last week.

Building permits issued in Winnipeg this year from January 1 to September 30, total $2,195,300, compared with $1,721,900 in the corresponding period in 1915. September permits covered 139 buildings whose estimated value is $231,850.

The Canadian Northern Railway Company is building houses at a number of divisional points on the Montreal-Port Arthur section of its transcontinental line. The conditions of occupancy for the company's employees have been made very easy.

The Montreal Board of Control has awarded the contract for the construction of the Lasalle Bridge and head gates in connection with the enlargement of the aqueduct to Mr. T. O. Sullivan, whose tender was considerably lower than the next bidder.

Hydro connection has been made with Toronto's new 60,000,000 gallon filtration plant at the Island and the pumps commence operations this week to test out three of the ten filters. The whole ten will be ready to operate, it is expected, by the end of the year.

A review of the reports issued by building inspectors and town and city engineers throughout the Dominion, covering the building permits which have been granted during the month of September, reveals a situation that should be very encouraging to the building trades generally. The figures in the majority of cases appear to be well in advance of last year, and only in very few municipalities do they show a decrease. We find some instances, too, where the values have soared in a most unexpected manner. Take our two big sea ports for example—Halifax' figures, totalling $350,000, are said to have broken all previous records, while Vancouver's total did not fall far short of the half-million mark and was nearly ten times greater than last year. Windsor, Ont., also registered a big increase for the past month, and present indications are that this will be the biggest building year in its history. Brantford, Ont., figures jumped from $5,295 to $56,090; Medicine Hat, from $580 to $21,000; and Port Arthur, Ont., helped out by some big construction undertakings, showed a total of $93,035, as compared with $2,220 in September, 1915.

The value of the building permits issued in the city of Medicine Hat, Alta., during the month of September this year is $21,000, as compared with $580 in the same month last year. The total for the first nine months of the year is $388,280, while during the corresponding period in 1915 the figure was only $53,640.

The city of Vancouver has won its case on appeal against Champion & White, contractors, in regard to the construction of the sea wall, near the site of the city market. The city engineer will now notify the Canadian Northern Railway Company to give instructions to the contractors to proceed with the work of constructing the sea wall at once.

An offer of $500,000 has been made by the Vancouver Harbor Board for the Kitsilano Indian Reserve, which they require in connection with a proposed scheme of port improvements. The Dominion Government price, however, is $1,250,000, and it has been necessary to appoint a special arbitration board to settle the matter.

Port Hope, Ont., has passed a factory aid by-law in favor of the Port Hope Sanitary Manufacturing Company, providing for exemption from taxes, except school and war taxes. The company will pay the town $650 rent per year for the land, and agree to employ a minimum of 50 hands, and to pay at least $25,000 in wages.

Rush orders have been placed in Pittsburgh, Pa., for steel to complete the new span for the Quebec bridge. The Dominion Bridge Company has placed a contract with the American Bridge Company to fabricate the new span and the Carnegie Steel Company will roll 5,000 tons of steel shapes and beams at its Homestead plant.

During the month of September this year 40 building permits were issued in Vancouver, B.C., value $415,350. Last September the permits issued numbered 40, at a value of $45,493. For the first nine months of the year 309 permits were issued, valued at $1,631,744, as compared with 515 permits during the corresponding period in 1915, value $1,338,844.

The value of the building permits issued at Brantford, Ont., during the month of September this year is placed at $56,090, as compared with $5,295 in the corresponding month last year. The figures for the fiscal year ending September 30, show that the permits in that time amounted to $255,757, or an increase of $68,577 over the previous 12 months.

During the month of September, 146 building permits were issued in the city of Montreal, valued at $205,456, as compared with 179 permits in the same month last year, valued at $350,896. The permits for the first nine months of the year, numbering 1,498, are valued at $3,787,010, as compared with $4,512,258 in 1915, when 1,618 permits were issued.

"Plaster Quarries Limited" is a new company formed by Montreal business men to operate extensive gypsum quarries at Island Point, Bras D'Or Lake, N.S. The capital stock of the company is $300,000. It is estimated that 100,000 tons of gypsum rock can be produced by the firm per year. The property contains probably ten million tons of gypsum, it is stated.

At the adjourned annual meeting of the Toronto Terminals Railway Company, which was held in Montreal, good progress was reported on the Toronto Union Station. It was stated that the stone was being delivered and cut preparatory to its erection, which is expected to be begun during the present month, the steel work being practically all completed.

The Quebec Streams Commission are distributing their fourth report covering operations of the commission for the year 1915. The personnel of the commission is as follows: Hon. S. N. Parent, K.C., chairman; William I. Bishop, C.E.; Ernest Belanger, C.E. Arthur Amos, C.E., is the engineer representing the Department of Lands and Forests. O. Lefebvre, C.E., is the chief engineer.

The survey of the Ottawa-Prescott highway has been recently completed. There are two approaches to the city of Ottawa, covered by the survey; one is along the government road between the canal and the Rideau River, and the other is along the toll road which passes through the experimental farm. It is stated that the Dominion Government is ready to widen the former road.

Mr. W. G. Chace and Mr. M. V. Sauer, both members of the Canadian Society of Civil Engineers, read a paper at the October 5 meeting of that society in Montreal, on the "Aqueduct for the Greater Winnipeg Water District." The paper also included a supplement, "Studies regarding Mixtures Employed in the Work," by Mr. W. G. Chace and Mr. D. L. McLean, the latter an associate member of the society.

At Copper Mountain, near Princeton, B.C., the B. C.

Copper Company has erected eight cottages and will erect several more. These cottages are 24 ft. x 26 ft. and contain 6 rooms. This company is also building a pumping plant near Princeton to raise water 1,700 feet from the Similkameen River, and then run it through a pipe 6,000 feet long, in order to supply the mine and village at Copper Mountain with water.

The complete plant of the Superior Tile Company, located at Rosslyn Village, near Fort William, Ont., is now in operation and is stated to be turning out something like 35,000 bricks per working day. Officials of the company say they have enough orders on hand to keep the plant running for some time. Between 35 and 40 men are now employed and the number may soon be increased. A new drying shed which was recently completed is now in operation.

Claiming his professional reputation has been seriously injured, City Engineer Laforest, of Hull, Que., has taken action against Ald. Chenier for slander, on account of an accusation voiced by the latter at a council meeting, when he alleged that the city engineer, while employed by the corporation, had acted as resident engineer for the Allis-Chalmers Company, in the construction of an additional power plant at the waterworks station, and demanded his dismissal.

The value of the building permits issued in Halifax, N.S., during the month of September this year, estimated at $350,000, is stated to have broken all records for that city. The value of the permits for each month this year up to date follows: January, $24,880; February, $16,580; March, $4,332; April, $95,924; May, $144,141; June, $145,078; July, $171,970; August, $93,516; September (estimated), $350,000. Total, $711,562. In 1914 the best months were April, $183,425; May, $132,976, and July, $175,025.

The further widening of the channel at the First Burrard inlet, orders for which have been received from Ottawa, will prevent the city of Vancouver from connecting up the two 12-inch mains, the major portion of which still lie submerged in the Narrows, as they are directly in the path of where the government dredge Mastodon will be widening the channel shortly. The extra widening of the channel will not affect the three 18-inch steel mains which have been laid since the widening of the channel was undertaken. City Engineer Fellowes reported that when the dredging permitted it next spring, the cost of connecting the two 12-inch mains would be about $5,000 or $6,000.

T. McAvity & Sons, Limited, St. John, N.B., have published a four-page folder enumerating members of the firm and employees "Who have heard the personal call of patriotism, the call of honor, and who are risking their lives that their country may live and that freedom may not disappear from the earth." One page is devoted to the "Fighting McAvitys," in which five members of the family are illustrated, namely, Lieut.-Col. James L. McAvity, O.C., 26th Battalion, C.E.F.; T. Malcolm McAvity, D.S.O., Brigade Major, 5th Infantry Brigade, C.E.F.; Ronald A. McAvity, Major, Canadian Ordnance; Percy A. McAvity, Captain, 26th Battalion, C.E.F.; Thomas A. McAvity, Sergeant, 60th Overseas Battery, C.E.F.

An accident which was partly due to a calf trespassing on the road and partly to the unsafe condition of a culvert, which was about two feet short of the dirt road and had no protective rail on one side, near Cobourg, Ont., resulted in an automobile, and its occupants being precipitated over the edge of the culvert. The Cobourg Automobile Club wrote to the Ontario Motor League asking them to draw the matter to the attention of their solicitor. The legal opinion was that the municipality was liable to action on account of the dangerous condition of the culvert. It had the right to pass by-laws to prevent animals running at large on the highway, and if such a by-law had been passed, damages could probably be claimed from the owner of the animal.

Personals

Mr. J. Macgregor, superintending engineer, Halifax Ocean Terminals, Intercolonial Railway, is going overseas with the 239th Construction Battalion, in which he is major.

Mr. H. B. Muckleston, M. Can. Soc. C. E., assistant chief engineer, Irrigation Branch, Natural Resources Department, C. P. R., is a captain in the 4th Pioneers Overseas Battalion.

Mr. A. S. Clarson has been appointed engineer of the city of Verdun, P.Q. He was formerly on the staff of the Montreal Electrical Commission, and has also held municipal positions in England.

Mr. E. A. James, of the firm of James, Loudon and Hertzberg, consulting engineers, Toronto, has just completed a report for the Royal Commission which is investigating alleged irregularities in the Highways Department in connection with the South Saskatchewan Bridge at Saskatoon.

Major Arthur Dubuc, civil engineer, and formerly chief of the Montreal branch of the Federal Department of Public Works, has been appointed commander of the 22nd Battalion, French Canadian, in succession of Lieut.-Col. T. L. Tremblay, now in a London hospital. Major Dubuc has been wounded three times.

Professor Thos. H. Mawson, of Liverpool University, the English landscape architect and town planner, arrived in New York last week. He is on a lecturing tour of the United States universities and may visit Canada to give addresses on industrial villages for partially disabled soldiers, a movement which he has been promoting in England.

Mr. Wm. Gowrie, a civil engineer, who has spent the past ten years following his vocation in India, recently visited Vancouver on the way to his home in Japan, having been on a tour around the world. Mr. Gowrie stated that he found plenty of scope for his profession in the east, and in discussing the industrial life of India he expressed the opinion that the war would have a far-reaching effect. Manufactures, he said, were being carried on there as never before, and in his own business especially, he noticed a remarkable change; huge steel girders were being manufactured which were formerly imported.

Obituary

Mr. John Ferguson, who for 25 years followed the trade of building contractor and plasterer, passed away recently in Toronto, where he has had his home for a number of years.

James O. Brewster, a well-known resident of Harvey Bank, N.B., died recently at his home. The deceased had followed the occupation of carpenter and builder for many years and was highly respected by all.

Mr. J. Howard Jackson, head of the firm of Jackson & Company, civil engineers, died recently at Brantford, Ont., following a paralytic stroke. Mr. Jackson was born in England in 1847, and went to New Zealand in the early sixties, where he took up surveying. Some three and a half years ago he came to Brantford, joining his son in the civil engineering field.

Major James Sheppard, of Queenston, Ont., superintendent of the Welland County Good Roads System, was killed by a railroad train while driving his motor over a crossing at Brookfield. Major Sheppard has been with the good roads' movement since its inception in the province of Ontario, and was a director of its first Good Roads Association, and afterwards manager and vice-president. Last year $232,000 was spent on good roads construction in Welland County under his supervision.

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Engineering Aspects of Irrigation

IRRIGATION possesses very wide engineering possibilities and opportunities. In the early days, when the advantages of intensive cultivation and irrigated growth were little understood, and when the problem was only in an experimental stage, the artificial application of water to the land was made on a purely empirical basis. Little attempt was made to incorporate in irrigation the principles of engineering science. Structures for aiding the watering were roughly and often crudely built, capable, to be sure, of performing their functions, but lacking in the exactness and preciseness of design and construction that characterizes present practice. The hydraulic laws and principles were indifferently, if ever, applied or adapted to suit irrigation conditions. In recent years, however, so remarkable have been the developments that have been made along this line, and so extensively has artificial watering been employed that irrigation has become a highly specialized subject. It has taken its place within the range of engineering science, and its extensiveness and many-sidedness have increased the possibilities that lie in the subject.

* * *

A review of what irrigation means shows to what extent engineering ability is necessary, and indicates the wide opportunities that exist for its future development. The production of good and profitable crops, the transcendent purpose of all irrigation projects, depends largely on the skill and ability with which the works are constructed and the water applied. The enormous quantities of water which have to be stored in the mountains, pumped from wells, diverted from torrential streams, conveyed around hills and across valleys and finally delivered to the farmer, call for the highest ability and experience on the part of engineers in designing and constructing the needed works. Investigations to study the feasibility of irrigation projects and the preparation and surveys of the land involve expertness and an acquaintance with irrigation conditions. The heavy drafts which irrigation makes on water supplies and the close relationship which it bears to other uses of water are features that require careful investigation. Further, such problems as proper organization, co-operation, good management, and profitable returns open to the engineer an economic field that might well be considered within his range. Considering this economic aspect alone, there are copious possibilities for the exercise of engineering ability and the displaying of engineering knowledge. The planning of an irrigation scheme can hardly be separated entirely from efficient operation and management. It usually develops that the experience gained in planning and designing a system makes the engineer the best qualified man to operate it.

* * *

The broadness of the matter only serves to indicate the possibilities that are presented. In the matter of structures alone a very extensive field is opened. In an article relating to irrigation in this issue are reproduced photographs which serve to illustrate the nature of some of these works. An indication is gained of the requisite knowledge and skill that must be portrayed in their design. Such works as the flumes illustrated, miles in extent in many cases, are subject to as stringent applications of the laws of structural and hydraulic design as any other structure. The extensive use of concrete which has been promoted in recent years for irrigation works has extended the scope of design and given further opportunities to the engineer. The projects developed by the large irrigation companies in the West, covering in many cases hundreds of thousands of acres, are not without their very difficult and perplexing engineering problems—problems which require the painstaking and exacting skill of the scientific mind.

* * *

One feature of irrigation that is seemingly little considered is the matter of drainage. It has been pointed out that irrigation must be co-related with efficient and proper drainage. The two go hand in hand, and the consequences resulting from continuous irrigation show that proper provision must be made for carrying away excess water. Heretofore little thought has been given to the matter, but the disadvantages of the lack of drainage are so great as to warrant more extensive developments along this line. The porosity of the ground, the imperviousness of the subsoil, have potent influences on the degree of water loss and a lack

of drainage contributes in a very great degree to the injurious alkalinity of the soil. Experience on many projects has demonstrated that it is impossible to depend on the adequacy of natural drainage. Few irrigation systems can do without supplemental drainage by artificial means, and, indeed, the construction of an irrigation scheme may, in addition, involve an almost equally copious drainage system. This again is embraced within the wide field that is opened to the irrigation engineer. Drainage cannot be carried out in a haphazard manner or by empirical methods. It must be performed on an engineering basis, and the irrigation engineer must be as alive to the methods of removing water as of adding water.

That this aspect of the subject is being realized is indicated by the attention some universities and technical schools are giving the matter. Chairs in irrigating engineering have been established in many western universities, but as yet those in this portion of the country have not realized the opportunities that are open to graduates in irrigation engineering. We feel that before long the far-reaching nature of the subject will demand more specialized technical training than heretofore, and that opportunities and possibilities will be opened that will be well worth the consideration of the most notable and pre-eminent minds of the profession.

Possibilities in Activated Sludge

THAT the recovery of nitrogen from sewage has at last been brought within the range of a commercial practicability summarizes in one significant sentence a paper read before the American Chemical Society by Mr. W. R. Copeland, the chemist in charge of the Milwaukee sewage-testing station, and which is printed elsewhere in this issue. The activated sludge method is distinctive in that it gives to the dry sludge a higher percentage of nitrogen than other methods. It is this condition that seems to indicate the possibilities that lie locked up in activated sludge and suggests that profitable recovery may be more practicable than has heretofore been the case with other processes.

This problem has been before sewage engineers for a long time and they have given unlimited efforts to trying to solve the difficulty. If sewage treating plants can be operated so as to produce a fertilizer base, upon a profitable scale, then the usefulness of sewage treatment will be apparent in a commercial way.

The difficulty, as Mr. Copeland points out, is the problem of dewatering a material that is 99 per cent. water. That this can be overcome at a net profit is believed by many experts. The question of cost is not yet certain, but summing up the figures given, it appears that the dried sludge from the activated sludge can be sold for $9 to $15 per ton, while the cost of placing on the market will be about $8 to $12 per ton, with a possibility of reducing this in the case of large plants.

There is sufficient information, at any rate, to promise much for further investigation in this regard. There is still demand for more exhaustive research on the part of engineers, chemists and biologists and further experimentation with sewage systems. Now that hope is entertained for recovering nitrogen on a commercial scale, further attempts should be made to solve the problem completely. It will undoubtedly revolutionize sanitation methods.

Do Your Part

THE Military Hospitals Commission have recently circulated for publication in the Canadian press an article by A. R. Doble, president of the Khaki League, Montreal, entitled "What You Can Do for the Returned Soldiers."

It is felt that every Canadian should and can take an interest in returned soldiers, and, inasmuch as many have neither time nor opportunity to join an organization for that purpose, much must be done by individual and independent effort. The article referred to incorporates a few suggestions which may help to intelligently direct the individual's part.

Give Them a Welcome

When you see in the papers that any of the boys are returning to your neighborhood, get together with a few of your neighbors and give them a hearty reception.

Employment

Find out what jobs are vacant in your community. Make it a matter of pride for employers to give the first chance to a returned soldier. Encourage the men to get back to work. Loafing is bad for them, as it is for any of us.

If you are an employer, give the returned soldiers a fair show. It may take a little time for them to get their bearings. Have patience with them, and encourage them—they have suffered so much for you.

Advice

Be in a position to advise the returned soldier where to go in case of need. If you see one in any difficulty, try to help him out, or go with him where he can get proper attention. Help the men who have helped you.

In conclusion, take a personal interest in the returned soldiers. They don't need treating, nor coddling, nor charity, but they need human sympathy and kindness, as well as justice.

Canada owes her soldiers a debt which money can never pay. Will you do your bit towards paying it as above suggested?

Organizations

Some of the places where information and assistance can be obtained follow:—

The Military Hospitals Commission of the Dominion Government has its chief office at 22 Vittoria Street, Ottawa. Branch offices,—Room 301 Drummond Building, 511 St. Catherine Street West, Montreal, Que.; and 1 Queen's Park, College Street, Toronto, Ont.

The provincial organizations are:—Nova Scotia—Returned Soldiers Employment Committee, Metropole Building, Halifax; New Brunswick—Returned Soldiers Aid Committee, 49 Canterbury Street, St. John; Prince Edward Island—Returned Soldiers' Commission, Box 306, Charlottetown; Ontario—Soldiers' Aid Commission, Parliament Buildings, Toronto; Quebec—Soldiers' Employment Bureau, 64-65 Dandurand Building, 294 St. Catherine Street East, Montreal; Manitoba—Provincial Returned Soldiers' Commission, 185 Lombard Street, Winnipeg; Saskatchewan—Saskatchewan Division of the Military Hospitals Commission, Leader Buildings, Regina; Alberta—Central Provincial Committee of the Military Hospitals Commission, Government Buildings, Edmonton; British Columbia—Returned Soldiers' Aid Commission, Parliament Buildings, Victoria.

Some of the provincial organizations have local

committees in many towns, and more of these local committees are being formed.

There is the Khaki League, which maintains at its Khaki Club, 660 Dorchester Street West, a Soldiers' Employment and Information Department in charge of a returned soldier, in addition to which it operates another Club at 184 Peel Street, as well as the Khaki Convalescent Homes at 46 Belmont Park and 128 McTavish Street.

Khaki Clubs are also established in the cities of Quebec, St. John, N.B., and Halifax.

Pooling Contracting Equipment

The Montreal Builders' Exchange have had under consideration a scheme by which members who are general contractors may rent to their fellow members surplus equipment. In these days of dullness in the building trade many contractors have expensive plants which they are perforce obliged to store in yards, entailing a certain amount of cost to look after and also charges in the way of interest on capital. The object is to organize a method by which the various plants can be located in a central yard, and any portion rented to members who require it; or the scheme may be varied by eliminating the central yard, but retaining the idea of renting the equipment. This could be done through the secretary of the Exchange, who would be supplied weekly with lists of the various surplus equipment of the contractors. In the case of a contractor requiring a certain piece of machinery, he will get in touch with the secretary of the Exchange and make enquiries as to whether such machinery is on any of the lists. In the event of the machinery being available, the secretary will give the member who enquires, a description and the name of the member who is desirous of renting the equipment. The two parties are in this way brought together, and it then remains for them to settle the terms on which the rental will be made. The scheme is of advantage to both members or firms; the one is saved the expense of purchasing plant which may be required only for a given job, and the other obtains a rental for machinery which would otherwise be idle.

Toronto Branch, C. S. C. E., Condemns Employment of Alien Engineers

An interesting meeting of the Toronto branch of the Canadian Society of Civil Engineers was held at the rooms of the society at the Engineers' Club on Oct. 12, 1916. The subject for the evening was "The Quebec Bridge," and Messrs. Ambrose and Steenbuch, who observed the operations in connection with the recent attempt to place the central span, addressed the meeting. Mr. Steenbuch gave a short historical review of facts in connection with the bridge and, by the aid of slides, explained methods employed in the construction of the giant cantilever arms and of the central span. Mr. Ambrose confined his remarks more particularly to the methods of floating and raising the central span, these operations being illustrated by many photographs taken by the speaker, and which gave a clearer idea of the immensity of the task. Both speakers laid particular emphasis on the thoroughness and foresight with which every detail had apparently been worked out.

At the close of the meeting a resolution was carried unanimously that the Toronto branch convey to Mr. G. H. Duggan its sympathy and also its absolute conviction that success would crown the next effort to complete the bridge.

It was also resolved and unanimously carried that the Toronto branch convey its hearty congratulations to Col. Mitchell, one of its most prominent members at present at the front, on his well-earned promotion to the position of first staff officer of the Second British Army in France.

The matter of the Government employing alien engineers was also considered, and the following resolution carried:

"That the members of the Toronto branch condemn the practice of any government—federal, provincial, or municipal—employing alien engineers to the exclusion of Canadians competent to do the work. And, further, that a committee, consisting of Mr. G. A. McCarthy, chairman; Mr. L. M. Arkley, secretary-treasurer; Prof. Haultain and Mr. J. R. W. Ambrose, be appointed to consider this question at a joint meeting of the Canadian Manufacturers' Association, Toronto architects, and construction contractors.

Instruction in Public Service

The Bureau of Municipal Research, New York, through its Training School for Public Service, has arranged for two courses in municipal highway engineering and engineering administration respectively, to be given during the season October to May, 1916-17. A series of lectures in municipal highway engineering will be given by Prof. A. H. Blanchard, professor in charge of the graduate course in highway engineering, Columbia University, and will develop the field from the standpoint of the fundamental principles involved, important differences of opinion, and recent developments in modern practice. The course in engineering administration will be conducted by a number of eminent specialists, including Mr. E. P. Goodrich, acting director Bureau of Municipal Research; Mr. J. T. Fetherston, commissioner of street cleaning, New York, and Mr. George B. Ford, consultant to the committee on city plan, New York City, and will concern itself with problems that confront administrative, legal, financial, and executive engineering departments of civil subdivisions. These courses are arranged in accordance with the policy of the Training School for Public Service, which aims to prepare students for official and unofficial public service.

Arrangements have been completed for holding the next National Complete Building Exposition in the Grand Central Palace, New York, on March 5-11, 1917. At this show manufacturers and building material dealers will participate in exhibiting the best in construction, equipment, and furnishings, not only for homes but also for buildings of a more general sort—commercial, factory, and public. This exposition should arouse and maintain an unusual interest, coming as it does on the eve of the spring building season.

The Montreal Council have rejected a recommendation of the Board of Control asking for a credit of $45,000, to be paid to a consulting engineer for preparing and supervising plans for the proposed hydro-electric development. A special committee to whom the matter was referred were of opinion that the Council's engineering staff should do the work, or that it should be done under their supervision, and this was endorsed by the Council. A further report by the controllers, asking for $6,400 for preparing plans for bridges over the aqueduct, was returned for the same reason.

Irrigation Practice in the Canadian West

The Developments that Have Taken Place in Our Western Provinces in the Matter of Artificial Watering Within the Last Twenty Years

By Mr. E. F. Drake*

ANY person engaged in farming in a region of uncertain and often scanty rainfall must all too frequently suffer partial or complete crop failure from drouth. Such a person would, if he were dependent upon his farm for a living, have a choice of just two courses. He could plant drouth-resisting crops and adopt approved methods for conserving soil moisture, or he could supply nature's deficiencies by applying water artificially by irrigation—if, fortunately, there happened to be water available for that purpose. There remains, of course, a third alternative. He might give up in despair and move to some other district.

Not very many years ago it was not uncommon in the Western United States to see disappointed home-seekers "moving on" with all their household possessions loaded in a "prairie schooner" and the cow and the family dog trailing along behind. From Indiana or Illinois to Missouri, and from Missouri to Kansas, thence to Western Kansas, and even still farther west, went this sorry procession, always looking for the promised land, often disappointed, and usually poorer with each successive migration. Farming as practised by these "birds of passage" was a haphazard occupation. A crop failure was looked upon as a dispensation of Providence, which might be endured but could not be avoided except by moving on to some more favorable region.

Government Assistance.

The art of farming had advanced a step, or several steps, since those days. There are still those who farm by the old methods and who blame Providence for their lack of success, but modern methods are now being very generally adopted, and the up-to-date farmer now looks for the causes of his failures and then sets seriously to work to overcome them. In this he is materially helped by the research and experimental work carried on by the Government departments of agriculture. He may, for the mere asking, obtain expert advice on a wide variety of subjects, such as treatment of soils, selection of crops suitable to his local conditions, cultural directions, the breeding and care of live stock—in fact, he has but to state his problem and helpful advice is usually available.

But science can do little, if anything, to affect the volume or seasonal occurrence of rainfall. If a district is "dry" it is likely to remain quite as dry in the future as it has been in the past. There used to be a widespread belief that the breaking and cultivation of the prairie sod, the planting of crops, and particularly of trees, increased the rainfall. That belief has now been very generally abandoned. Certain beneficial changes do, indeed, result from cultivation of the soil. When the prairies were covered with tough, unbroken sod a very considerable proportion of the rainfall ran off and was wasted, while now it sinks into the loose, cultivated soil and is stored and made available for the growing crops. But evidence is lacking that these, or other, changes have any material effect on the amount of the annual rainfall.

Volumes have been written on the subject of dry-farming, or methods of farming suitable to semi-arid regions, and many other volumes dealing with the practice of irrigation. The purpose of this article is not to discuss either of these farming methods in detail, but merely to draw attention to the development of irrigation in Western Canada within the past twenty years. Dry-farming has made equal progress within the past few years, but that is another story. There is, however, no conflict between these two methods of farming; they may be, and in fact frequently are, practised on the same farm, and the irrigation farmer who does not practise cultural methods for the conservation of soil moisture is neglecting a vital point in the game.

In a comparatively small district in the southern part of the Province of Alberta some $20,000,000 have been expended in the construction of irrigation works. This money has not been spent by faddists or by promoters who hoped to get quick returns and large profits, but by conservative business men, who, after careful investigation, were convinced that the investment will eventually be profitable to themselves and beneficial to the whole community.

The First Canadian Water Law.

The development of irrigation farming began about 1894, when the first Canadian water law was enacted, under the title of "The North-West Irrigation Act." The essential features of this law are:

1. That the water in all streams, lakes, springs, ponds, or other surface sources of water supply is the property of the Dominion Government.

2. That the right to use this water may be obtained by companies or individuals upon compliance with the provisions of the law.

3. That the uses for which water rights may be so acquired are:

(a) Domestic, which includes household and sanitary purposes and all purposes connected with the watering of stock and the operation of agricultural machinery by steam;

(b) Municipal, i.e., the supply of water to towns and cities;

(c) Industrial, i.e., the operation of railways and factories by steam;

(d) Irrigation; and

(e) Other purposes than those above-mentioned.

4. That the individual or company acquiring such a water right shall be given a clear and indisputable title to the right to the use of the water so long as he shall continue to apply it to beneficial use.

5. That such rights may be forfeited by abandonment, waste, or non-use.

6. That holders of water rights shall have the protection and assistance of permanent government officials in the exercise thereof, and that all disputes and complaints in connection therewith shall be referred to and settled by such officials, whose decisions shall be final.

There had been a considerable development of irrigated farming in a small way in the foothills region of Southern Alberta, but the individual projects were for the most part small, and had been installed by ranchers for the purpose of growing forage crops in connection with their cattle raising industry. Surveys were made under the direction of the Dominion Government at

* Superintendent of Irrigation, Department of the Interior, Ottawa.

about the time of the passing of the Irrigation Act, which demonstrated the feasibility of diverting water from streams in the Province of Alberta for the irrigation of three large tracts of land. These surveys were not carried out in detail, but were confined merely to a determination of the feasibility of diverting water from the several sources of supply and conveying it to certain tracts which seemed to be well adapted to the practice of irrigated farming.

Alberta Railway and Irrigation Company.

The first of these surveys indicated that a considerable tract of land in the vicinity and south of Lethbridge, Alberta, could be irrigated at reasonable cost,

An irrigation flume of the Southern Alberta Land Co.—One mile long.

and a study of the climatology of the region indicated very clearly that the practice of irrigated farming should be highly beneficial. The construction of works was begun about 1899. The main canal taps the St. Mary River at a point about five miles from the international boundary, and runs in a general northeasterly direction as far as Lethbridge, where it turns east and slightly south. This canal has a present capacity of about 1,000 cubic feet per second, which is, theoretically, sufficient to irrigate about 150,000 acres of land. It is probable that about 75,000 acres have so far actually been irrigated in this region.

The Alberta Railway and Irrigation Company owned and operated a line of railway known as the Alberta Railway and Coal Company, which, with connecting lines, runs from Lethbridge to Great Falls, Montana, and also owned the Galt coal mines at Lethbridge. This road had received a considerable grant of land, which lay chiefly in the district south and west of Lethbridge and was traversed by the main canal. The company hoped to encourage irrigated farming in the district, and by that means to enhance the value of its land. The company's profits would accrue through the higher prices obtained for otherwise almost worthless land and by the increased railway traffic due to settlement.

These hopes have, in large measure, been realized. A colony of Mormons was imported from the United States because of their familiarity with irrigation. These Mormons settled in the vicinity of Cardston, worked on the construction of the irrigation system, purchased land from the company, and soon established a highly prosperous farming community upon land that had formerly been regarded as fit for nothing but grazing, and not particularly valuable even for that. There may be differences of opinion as to whether the Mormons have been a desirable addition to our population, but they have certainly been successful farmers, and the country about Cardston, Raymond, Magrath, and Stirling is now highly productive and prosperous.

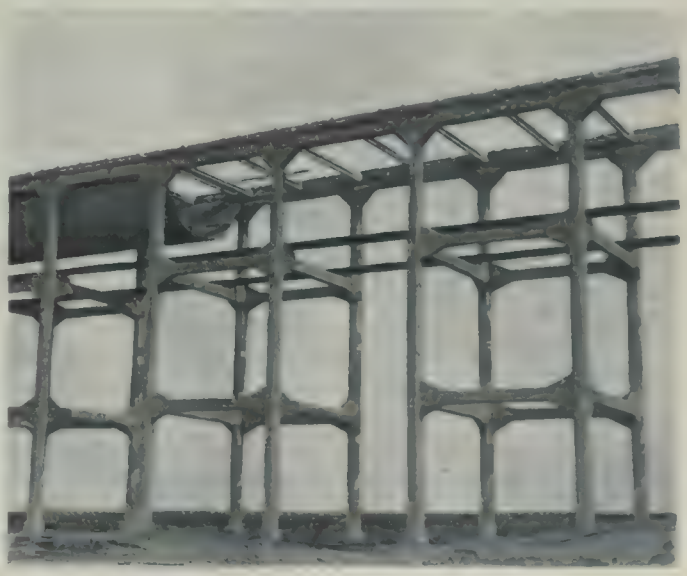
Extent of the System.

The company's canal system comprises 231 miles of main canals and natural channels, with a maximum bottom width of 45 feet in the main canals and from 20 to 25 feet in the secondary canals. The constructed works have cost in the neighborhood of $1,300,000. There are approximately 130,000 acres of land irrigable from the works as they stand to-day, and probably some 75,000 acres have actually been irrigated. The annual maintenance charge, sometimes called water rental, is equivalent to $1 per irrigable acre. The present system of works is susceptible of considerable expansion, but further development is dependent to some extent upon the availability of the necessary water supply, the main sources of supply being St. Mary and Milk Rivers, which are both international streams, and subject to the provisions of a treaty between Canada and the United States providing for the joint use of the waters by the respective countries for irrigation and power.

The works originally constructed by this company, while well built and quite sufficient for present purposes, were not of the most modern type, but as the wooden structures decay they are gradually being replaced by others of reinforced concrete, while improvements in the canal are made from time to time as necessity requires.

Beet Culture.

An extensive beet sugar factory was established several years ago, and the culture of sugar beets by means of irrigation was practised on a considerable scale for some years. The industry progressed far be-



The Brooks Aqueduct, approximately 2 miles in length. The bents are 51 ft. at highest point.—C.P.R. Irrigation scheme.—See also next figure.

yond the experimental stage, and was recognized as a profitable form of agriculture, entirely suitable to this district. Recently, however, the growing of sugar beets has fallen off, and it is understood that the factory has been closed. Presumably one of the reasons for this is the scarcity of reasonably cheap labor for handling the crop.

Alfalfa.

Alfalfa growing is now rapidly coming into favor. The oldest alfalfa fields were sown in the vicinity of

Lethbridge some fifteen years ago, and many of them are in first-class condition to-day. With good care and under favorable conditions three crops a year can be cut, with a total yield of about six tons per acre; two cuttings, averaging four tons, may be relied upon. These results can, however, only be obtained under irrigation, and they furnish striking proof of its value, as, without irrigation, the yield of forage crops in this district is uncertain and scanty. There are now more than 15,000 acres sown to alfalfa in the Lethbridge district.

The Canadian Pacific Railway Irrigation Company.

Another of the large irrigation projects, the feasibility of which was determined at an early date by governmental surveys, was subsequently taken up by the Canadian Pacific Railway Company. The lands comprised in this project form a block about 125 miles in length east and west, with an average width of about 50 miles, lying along the main line of the company's railway immediately east of Calgary. The tract comprises about 3,000,000 acres, and was acquired by the company as part of the grant in aid of the construction of its railway line.

The annual precipitation within this tract varies considerably from year to year and in different portions of the tract, the precipitation generally decreasing in volume from west to east. The average at Calgary from 1886 to 1910 was 16.4 inches; the minimum being 6.90 inches in 1889 and the maximum 31.90 inches in 1902. The average during the irrigation period from 1st May to 30th September for the same years was about 12 inches.

Western Section.

The tract has been divided by north and south lines into three sections, known as the eastern, central, and western sections. Work was first commenced on the western section, which is supplied from the Bow River at Calgary by a main canal with a present theoretical capacity of about 2,200 second-feet. The western section contains 1,039,620 acres, of which about 223,000 acres are irrigable.

The works comprise a diversion weir and headgates at Calgary, a main canal 16 miles in length, with a capacity of about 2,200 second-feet, and secondary canals and laterals with a total length of 2,484 miles. The total cost of the constructed works has been slightly in excess of $4,000,000. The annual water rental or maintenance charge is 50 cents per irrigable acre. While the works for the irrigation of this section of the project have only recently been finally completed, they have been in partial use for some eight years, and irrigated farming has been practised to a considerable extent in several portions of the tract.

Central Section.

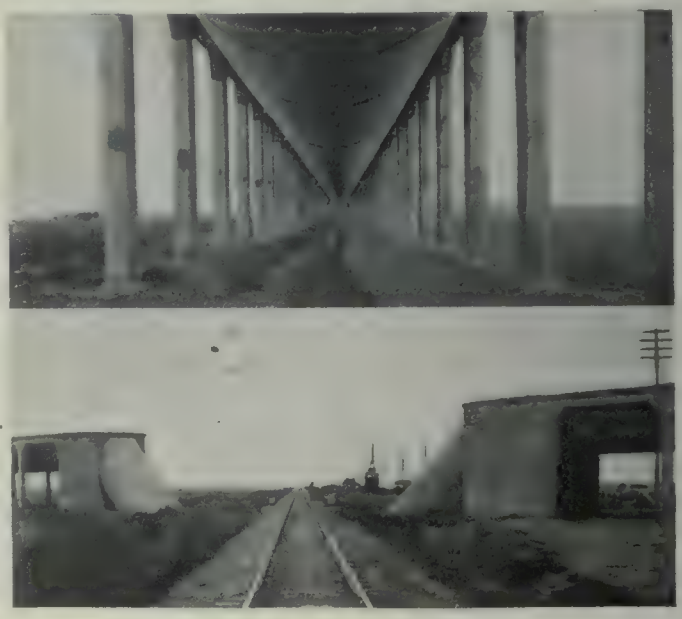
The central section contains about 900,000 acres, of which only about 75,000 acres are irrigable under present conditions, and this area can be irrigated by extensions of the main canals from the western section. No actual construction work has yet been done on this section, and it is not the company's intention to develop this section at present. Ultimately it may be found feasible to irrigate a much greater area in this section.

Eastern Section.

The eastern section contains 1,156,000 acres, of which about 400,000 are irrigable. Water for this section is taken from Bow River at what is known as "Horse-shoe Bend," about 85 miles east of Calgary, where a concrete dam has been built about 720 feet long with a minimum height of about 40 feet to the overflow crest, above which 11 feet of water will be held by movable gates. Connected with this concrete dam is an earthen embankment, or dam, 7,000 feet long and 45 feet in maximum height, 32 feet wide on top and 310 feet wide at the base in the section of its greatest height. Water is diverted through five steel sluice-gates into the main canal and thence by an elaborate system of canals, reservoirs, flumes, etc., is distributed throughout the tract to be irrigated. The works consist, in addition to the dam and intake, of 2,500 miles of canals and ditches and a reservoir with a storage capacity of 186,000 acre-feet. The system has only recently been completed sufficiently to warrant the sale of land, and of the 400,000 acres of irrigable land in this section only about 8,000 acres have so far been irrigated. The cost of the works has been about $9,500,000.

The annual water rental or maintenance charge is $1.25 per irrigable acre, but the water contracts provide for a reduction to 75 cents per acre in the event of the water users forming associations and taking over the maintenance of the works and the distribution of the water within their own districts, in which case the company's responsibility will be limited to the maintenance of the main canal systems and the delivery of water at the upper end of each water district. No such associations have yet been formed, as the district has only recently been opened for settlement, and, in fact, no water rental has yet been charged, although two or three small colonies of settlers have been supplied with water for two years.

The works in this section are of the most modern type, and practically all the structures are of reinforced concrete. The land is well adapted to irrigated farming, and it is expected that the district will eventually be one of the most thickly settled and prosperous in the province. Immediate development, however, will probably be retarded by conditions arising from the war.



The Brooks Aqueduct on Western section, C.P.R. Irrigation System. The upper picture shows the columns and bottom of shell. The lower illustrates a syphon under the railroad tracks.

Southern Alberta Land Company.

The third project surveyed by Government engineers covered a tract of several hundred thousand acres lying chiefly between the Bow and Oldman Rivers, south and east of the Canadian Pacific Railway Company's tract. Within this district the Southern

Alberta Land Company was permitted to purchase some 380,000 acres of land which are to be irrigated from a canal which taps Bow River at a point about 30 miles southeast of Calgary. A diversion dam has been built across the river, and by it water is turned into a canal and carried for a distance of some 45 miles to a reservoir known as Lake McGregor, which by means of large earthen dams at its northern and southern ends contains about 300,000 acre-feet of water, or sufficient to irrigate some 180,000 acres of land.

The water is drawn from the reservoir at its southern end and carried by a large canal in a general easterly direction to and through the tract to be irrigated, and branch canals and distributaries will be constructed at suitable points. Part of the tract lies east of the Bow River, and the water for its irrigation is to be carried across the river in huge pipes slung under the roadbed of a bridge, which is also to be used for general traffic purposes. The eastern limit of the tract is near Suffield, a town some 25 miles west of Medicine Hat.

A Large Storage Reservoir.

The most noteworthy point about the canal system of this company is the huge reservoir, where can be stored almost enough water for one year's supply, thus making the company practically independent of the fluctuating flow of the river from which its supply is drawn.

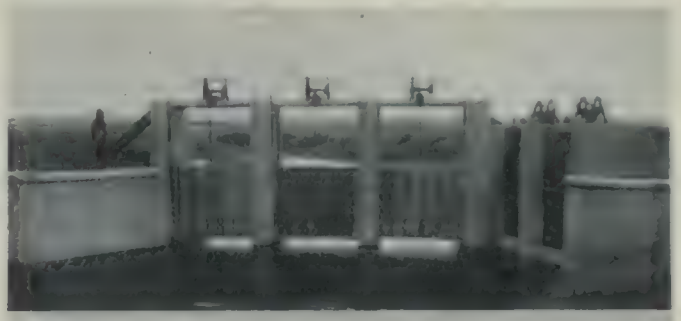
The constructed works, other than the dam and reservoir previously referred to, consist of some 300 miles of canals and a smaller reservoir with a capacity of 30,000 acre-feet, several flumes, and two wood stave syphons, one of which (not completed) carries the water across Bow River to the easterly portion of the tract to be irrigated. The works so far constructed have cost a little over $5,000,000. No land has yet been sold or irrigated.

The tract to be irrigated comprises some 442,000 acres, including the tract purchased from the Government subject to irrigation conditions. The area actually irrigable is approximately 153,000 acres. The works are not yet completed, and further construction has been temporarily abandoned owing to financial difficulites. If these are satisfactorily adjusted it is the company's intention to proceed with development as rapidly as possible. The plan now proposed is to develop the tract in units, beginning with a block of some 20,000 acres in the extreme westerly portion of the tract, and not to attempt the development of further units until practically all of the land within the first unit has been sold and occupied. This plan has much to recommend it. It ensures economy in the operation of the canal system, and will probably be profitable to the company in connection with the sale of the remainder of its lands. If the practice of irrigation on the first unit of the tract is successful it will enhance the value of the remainder of the lands.

Development of Smaller Irrigation Projects.

While the construction of large irrigation projects such as those already mentioned is of more general interest to the public, it by no means follows that the larger projects are of more general benefit to the country than the smaller ones. Here and there throughout the southern part of the Province of Alberta and in the Cypress Hills region in the southwestern corner of the Province of Saskatchewan are to be found small irrigation projects which have been developed, perhaps crudely and cheaply, by the owners of the land. Here irrigation has been intelligently practised for several years, with decidedly beneficial results. In many cases these small projects have resulted in the reclamation of what are known as "gumbo flats" and other tracts of land which, under natural conditions, were of very little value for any purpose. These have been converted into profitable meadows of native or cultivated grasses and alfalfa.

There are in the neighborhood of 400 of these smaller irrigation projects scattered throughout the southern portion of the two provinces and comprising in the neighborhood of 110,000 acres of irrigable land. No accurate cost data has been kept with respect to



Upper—The North and West Bantry Headgates, C.P.R. Irrigation System.
Lower—The North and South Bantry Headgates.

these smaller projects, and in only a few cases would it be possible to ascertain even the approximate cost of the works. Most of the work has been done by the settlers themselves, and in the comparatively few cases where work has been let by contract, or where cost data has been kept, this covers only a small portion of the project. It might be fair to assume, however, that the works have cost in the neighborhood of $5 per irrigable acre, which would bring the total cost to about $550,000.

A summary of irrigation development would, therefore, be approximately as follows:

Project.	Area Irrigated. Acres	Cost
Alberta Railway and Irrigation Company	150,000	$1,500,000
C.P.R. Company, western section	223,000	4,000,000
C.P.R. Company, eastern section	400,000	9,500,000
Southern Alberta Land Company	153,000	5,000,000
Alberta Land Company	49,000	490,000
Smaller irrigation projects	110,000	550,000
	1,065,000	$20,840,000

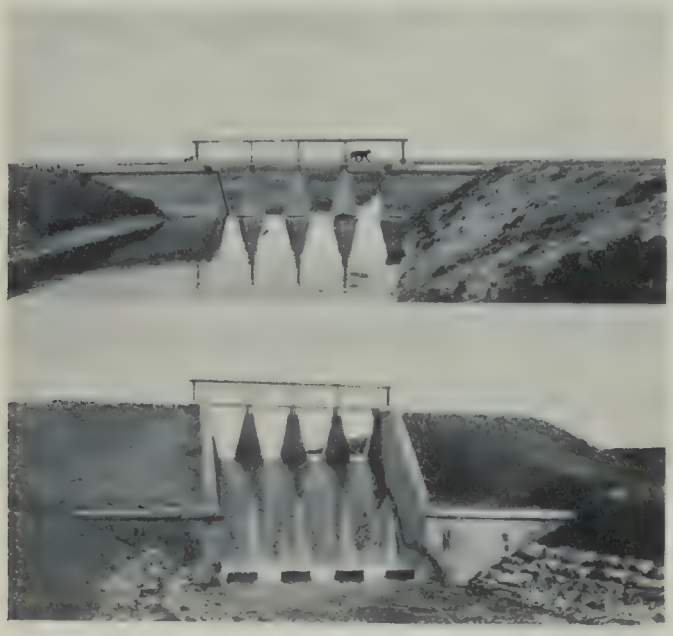
Benefits from Irrigation.

Perhaps no better proof can be given of the value of irrigation in regions of scanty or uncertain rainfall during the crop-producing season than the results obtained in the Lethbridge district in Southern Alberta during the past ten or fifteen years. The cultivation of alfalfa in that district is a proven success, and, with reasonable care in the application of water and the harvesting of the crop at the proper time it is safe to say that approximately five tons per acre per annum

can be grown. Alfalfa in this district has a selling value of about $10 per ton, but experiments conducted at the Dominion Government experiment station near Lethbridge indicate that its feeding value is between $16 and $17 per ton; in other words, if a farmer chooses to sell his crop he may reasonably expect a gross return of about $50 per acre; whereas, if he is the fortunate possessor of sufficient live stock and feeds the crop on his own farm, he may expect a return of from $80 to $85 per acre, and, in addition, will have the benefit of the manure for fertilizer.

The continuous growing of any one crop is usually believed to result in soil impoverishment, but this is not the case with alfalfa, which, on the other hand, always has a beneficial effect because of its ability to absorb nitrogen from the air and store it in the soil.

Alfalfa is, however, by no means the only crop that can be successfully grown under irrigation. All the native and cultivated grasses respond readily to irrigation, while very beneficial results have followed the judicious application of water to grain crops. For example: In 1912 wheat grown on non-irrigated land produced 31 bushels per acre at the Lethbridge Experiment Station, while irrigated wheat produced 63 bushels per acre. The average for six years at this station shows that irrigated wheat produced an average of 20 bushels per acre more than non-irrigated.



A drop on the Canadian Pacific Irrigation System. View from above and below. The structure s of concrete.

Heavy Yields of Grain.

Similarly, at the same station oats on dry land in 1912 yielded 77 bushels per acre and on irrigated land 145 bushels, the average increased yield for the six-year period being 42 bushels per acre.

The record for barley in 1914 was 30 bushels on non-irrigated land and 97 bushels on irrigated land. The average increased yield for the six-year period was 38 bushels.

The average increased yield for potatoes during a seven-year period was 258 bushels under irrigation, as compared with dry-farming, the greatest difference in any one year being in 1909, when the potatoes on dry land yielded 159 bushels and on irrigated land 605 bushels per acre.

These illustrations are extremes, but, admitting that, they very clearly show the increased yields that can be expected if farmers will carefully cultivate their land and will apply irrigation water intelligently. Unfortunately, a great many of the settlers in the West who have heretofore attempted to farm by irrigation have apparently been of the opinion that it was only necessary to open the headgates and turn the water on to the land in order to ensure the maximum benefits. Very little attention is given by many of the farmers to the tedious and somewhat expensive work of smoothing the land so as to permit of the equal distribution of water over the entire surface to be irrigated, but, unless this is done, good results cannot be obtained. Turning on the water and permitting it to run at will over an improperly prepared field will result in drowning out crops in the depressions while leaving the hummocks untouched, and. in addition, the water will very probably escape from the boundaries of the irrigator's own farm and damage the lands or crops of his neighbor or the adjacent road allowances.

Education in Irrigated Farming Necessary.

It apparently takes a long time to teach some settlers that irrigated farming is an art that must be learned. The writer heard a settler in Southern Alberta complaining that irrigation was no good; that it had been tried out on his farm for several years and the results had not been at all satisfactory. The settler was himself attempting to flood a field of young alfalfa and was having a good deal of difficulty in controlling the water. It was learned, upon questioning him, that he had spent all his earlier life in mercantile pursuits in the city and had, in fact, during his later years been a banker; that he had absolutely no knowledge of agriculture prior to the current year, when, being unable to get anyone else to run his farm, he had undertaken to do so himself. He was disappointed at the results, and inclined to blame irrigation for his lack of success. What would this settler have thought of a farmer without any acquaintance with business, and particularly with banking methods, who had essayed to run a bank in a city? He would probably have characterized him as a fool, and would have had little sympathy for him when he lost his investment. It is unwise to embark in any line of business without a thorough acquaintance with all its details, and there is no royal road to success in farming.

Water Supply vs. Area Requiring Irrigation.

The area in the Provinces of Alberta and Saskatchewan that require, or will be benefited by, irrigation may roughly be described as a tract of from forty to fifty million acres, comprising the southern portion of the Province of Alberta and the southwestern portion of the Province of Saskatchewan. Not all of this large area requires irrigation, but most of it would be materially benefited by the practice of irrigated farming, and in some regions irrigation is believed to be absolutely necessary for successful crop production throughout a series of years. There is no really arid land in Western Canada as the term "arid" is generally understood in the Western United States. There is probably no portion of this district in which in occasional years the rainfall is not sufficient for crop production. In 1915, the "year of the bumper crop," some of the finest crops produced in Western Canada were grown on land which in 1914 had not raised enough grain per acre to keep a gopher alive.

Only a Part of the Land Irrigable.

Unfortunately for the future development of portions of this so-called semi-arid tract, the available water supply will only suffice for the irrigation of a comparatively small proportion of the total area, and,

moreover, a considerable portion of the entire tract is too rough, or too high, to permit of its irrigation within reasonable limits of cost. It is probable that not in excess of five million acres will ever be successfully irrigated within this district; in other words, the water supply will be sufficient for about one-tenth of the total area. If, however, but one-tenth of this area is actually developed and intelligently farmed under modern methods of irrigation, the results will be astounding, and will not only double or treble the value of the irrigable land, but will at the same time materially increase the value of the adjacent non-irrigable land.

Treatment of Wood Paving Blocks

The essential features in the proper treatment of wood paving blocks consist in obtaining an even and thorough diffusion of the oil through the wood, so far as possible, and in so controlling the operation of treatment that the "bleeding" and swelling of the pavement will be reduced to a minimum, is the statement made by C. H. Teasdale, of the Forest Products Laboratory at Madison, Wis., in a recent address before the American Society of Municipal Improvements.

In formulating specifications for wood paving blocks in the past, it was stated, the principal consideration has been given to the properties of the preservative, while the importance of the method of treatment has been underestimated. Engineers are now beginning to realize that the methods adopted for treatment are probably the most vital consideration in the successful production of wood block paving.

By "bleeding" of wood paving blocks, Mr. Teasdale explained, is meant the exuding by the blocks or the filler between them of a bituminous material, which becomes a nuisance when deposited upon the surface of the pavement. Swelling of the blocks may give rise to buckling of the pavement or shearing or displacement of the curb. In order to avoid these troubles and still obtain durable pavements, according to Mr. Teasdale, the timber should be treated while green, and given a thorough steaming and vacuum treatment before the oil is forced into the wood. The object of these operations is to remove air from the wood cells. Another very important point in the treatment is to be certain that the oil is not applied too rapidly. In order to obtain the best penetrations of the preservative it is recommended that the pressure be raised very gradually and that the maximum pressure should not be too high. Subsequent to treatment with the oil, a steaming and vacuum period may be employed if thought desirable. This operation removes dirt and tarry matter from the surface of the wood and makes the blocks bright and clean, even when oils containing much tar have been used as the preservative.

Mr. J. Quinlan, president, and Mr. D. Trotter, secretary, represented the Montreal Builders' Exchange at a dinner organized by the Canadian Credit Men's Trust Association, and held on October 3, in Montreal. The object was to discuss the subject of legislation as it affects commercial questions, particularly in the matter of credits. Mr. Quinlan and Mr. Trotter made special reference to the Quebec law governing the relations of contractors, architects, supply men, merchants, men and owners. The law, said Mr. Quinlan, seemed perfect, but in actual working it was defective and required amendment to make it workable.

Cost of Operation of the Central Heating Plant, University of Toronto

The following tables give some interesting information regarding the cost of operation and the efficiency of the central heating and lighting system of the University of Toronto. They are taken from a paper by L. M. Arkley, assistant professor of mechanical engineering at the university, recently reproduced in Power. The tables show the temperatures reached in the different months of the winters of 1912-13, 1913-14, 1914-15, and the cost of heating per square foot of radiation during these years:

Temperatures and Coal Used.

	Average Temp., 1912-13, Deg.	Daily Coal, 1912-13, Tons.	Average Temp., 1913-14, Deg.	Daily Coal, 1913-14, Tons.	Average Temp., 1914-15, Deg.	Daily Coal, 1914-15, Tons.
October	50.6	17.0	51.6	14.2	52.75	13.2
November ...	40.5	36.5	42.4	31.4	38.13	29.1
December ...	32.6	49.0	33.4	35.7	25.72	41.5
January	31.3	43.8	25.5	46.0	23.62	44.5
February	20.4	58.2	15.5	57.4	26.04	44.9
March	33.3	42.8	30.8	37.6	29.93	38.6
April	46.3	23.6	41.5	24.2	49.82	18.6
May	54.3	10.1	58.5	10.1	52.15	7.0

Data on the Cost of Operation.

	1912-13		1913-14		1914-15	
	Total cost.	Cost per sq. ft. radiation, cents.	Total cost.	Cost per sq. ft. radiation, cents.	Total cost.	Cost per sq. ft. radiation, cents.
Cost of coal	$29,429.52	17.23	$26,649.23	15.12	$25,135.64	12.80
Cost of city water.	510.62	0.30	265.90	0.15	220.00	0.11
Repairs and renewals	2,393.39	1.41	3,674.89	2.08	5,354.06	2.73
Salaries (engineers, firemen, helpers)	8,713.81	5.12	7,992.47	4.54	7,972.25	4.05
Electric current purchased	1,100.66	0.65	1,424.24	0.81	1,329.32	0.66
Total cost of operation	$42,148.00	24.71	$40,006.73	22.70	$40,000.37	20.35
Total sq. ft. radiation	170,221		176,203		196,534	
Total current generated, kw. h.	395,395		351,231		390,655	
Total water evaporated, lb.	112,329,994		121,657,911		117,424,163	
Total cost of coal required for evaporating 1,000 lb. of water under observed conditions, cents	26.2		21.9		21.4	
Cost of evaporation per 1,000 lbs. steam, cents	28		33		34	

The increased charge on repairs and renewals is accounted for by extensive alterations which have ultimately reduced the cost of operation. In this distribution of cost no charge is made for light and power in low pressure service.

The Hamilton Steel Wheel Company has purchased a site and will erect a plant costing $200,000, for making steel wheels, which product was formerly furnished by Germany and the United States. This industry will give employment to about 200 men, and will turn out about 75 tons of steel wheels per day. C. W. Sherman, of the Dominion Steel Foundry Company, will be managing director of the new concern.

Mr. John Quinlan presided at the opening luncheon of the season of the Montreal Builders' Exchange on Oct. 5. The address was by Controller J. Villeneuve, who described at length the objects of Bureaux of Municipal Research now established in many cities on this continent. He dealt in detail with the local municipal situation, and suggested that many needed reforms could be effected by means of a Montreal bureau.

Nitrogen Recovery from Sewage Sludge

A Paper and Discussion Indicating the Commercial Possibility of Deriving Fertilizer Base on a Practicable and Profitable Scale

THERE are indications that nitrogen can be recovered from sewage sludge on a commercially practicable scale, and that, in the form of fertilizers, profits may be expected from activated sewage wastes. In a paper read before the water, sewage, and sanitation section of the American Chemical Society at the recent annual convention, Mr. W. R. Copeland, chemist at the Milwaukee sewage-testing station, discussed the practicability of this problem. Mr. Copeland's paper is reproduced substantially in full herewith:

The answer to the question as to whether it is or is not practicable to recover the nitrogen in sewage and sewage sludge will depend upon three factors: (1) The amount of nitrogen contained; (2) the cost of recovering and disposing of the nitrogen; (3) the market value of the nitrogen.

Recovery of nitrogen, from the standpoint of this paper, has to do principally with the nitrogen in suspension, because that is the portion which appears in the greatest quantity in the sludge. The total obtained will vary both with the treatment process used and with the volume contained by the raw sewage (see Table I.).

Table I.—Composition of Dry and 10 Per Cent. Moisture Sewage Sludge.

Source of sample.	Sludge obtained from	P.C. of Nitrogen
On the Basis of Dry Sludge.		
Frankfurt-am-Main	Plain sedimentation	2.85
Columbus, Ohio	Septic tank	1.40
Essen	Imhoff tank	1.22
Philadelphia	Imhoff tank	1.20
Worcester, Mass.	Chemical precipitation	2.77
Sludge Computed on Basis of 10 Per Cent. Moisture.		
Brooklyn (Williamsburg)	Dickson (yeast) process	1.4
Columbus testing station	Grit-chamber sludge	1.2
	Plain sedimentat'n tank	1.6
Philadelphia testing station	Plain sedimentat'n tank	1.2
Cleveland testing station	Plain sedimentation	1.4
	Septic tank	1.3
	Imhoff tank	1.2
Gloversville testing station	Plain sedimentation	2.3
	Septic tank	2.2
Worcester, M. & E., Vol. III.	Plain sedimentation	2.7
	Septic tank	2.7
Atlanta	Imhoff tank	1.5

Data given in the tables show that the sludge which has been obtained heretofore by the best-known processes of sewage treatment (plain sedimentation, septic and Imhoff tanks) contained from 1.2 to 3.0 per cent. of nitrogen. These figures are low, and indicate that the sludge did not possess as much nitrogen as the amount contained by the raw sewage would lead us to expect. This condition may be explained by the fact that a large share of the colloidal matter carried by the sewage ran out in the effluent flowing away from the tanks and took nitrogen with it. In the case of chemical precipitation works, the lime added drove nitrogen off in the form of ammonia and diluted the portion remaining by increasing the amount of inert mineral matter. Moreover, various authors state that from 10 to 60 per cent. of the volume of the solids deposited by sewage in the sludge-digestion chambers of Imhoff tanks and other forms of septic tanks is converted into soluble or gaseous form. Much of the albuminoid ammonia is thus changed into free ammonia and free nitrogen, which escape in the liquor or bubble out at the gas vents.

The Activated Sludge Process.

Within the last two years, however, a new method of sewage purification by the so-called "activated-sludge" process has been tried out in various cities of America and England. One of the distinctive features of this process is that the colloidal and suspended matters of the sewage are collected in the sludge. If this is not reaerated or overaerated the solids are not liquefied to such a large degree as they are in septic tanks, and therefore the nitrogen does not escape.

For example, the digested sludge accumulates in Imhoff tanks at a rate of from 4 to 10 cubic yards per 1,000,000 gallons of sewage treated, whereas by the activated-sludge process 20 to 80 cubic yards or more may be deposited in the settling tanks, varying widely, of course, with the strength of the sewage and the water content of the sludge.

The Milwaukee sewage-testing station carried on a series of experiments during the summer of 1915, where the city sewage was treated by the Imhoff and activated-sludge processes simultaneously. Analyses of the sewage effluents and sludges are given in Table 2.

Table 2.—Analyses of Milwaukee City Sewage Before and After Treatment by Imhoff Tank and by Activated Sludge.

	Parts per million.					
		Nitrogen as				
		Ammonia.				
Period of test, 1915. / Source of sample.	Suspended matter.	Free.	Albuminoid.	Organic nitrogen.	Nitrite.	Nitrate.
August:						
Sewage	253	14.6	7.88	29	0.15	0.13
Imhoff effluent	105	16.2	6.10	27	0.19	0.13
Activated-sludge effluent	14	3.8	3.19	6	0.29	6.00
September:						
Sewage	300	13.5	8.81	29	0.25	0.14
Imhoff effluent	116	15.4	7.10	27	0.12	0.09
Activated-sludge effluent	8	5.7	2.22	9	0.24	5.01

Samples of digested sludge from the Imhoff tank and of the fresh activated sludge were also collected and analyzed in August and September. While it is not correct to say that these sludges represent all of the raw sewage passed through these tanks during August and September, it is fair to assume that they are typical of the sludge which was being produced by those processes at that season of the year. Therefore, the analyses of the sludges are given in Table 3.

Table 3.—Analyses of Samples of Imhoff and Activated Sludges Obtained from Milwaukee Sewage.

Date, 1915. Source of sample.	Nitrogen reported as NH_3 on basis of sludge dried to 10 per cent. of moisture.
August:	
Imhoff sludge	2.87
Imhoff sludge	3.82
Activated sludge	5.71
Activated sludge	4.97
Activated sludge	7.04
September:	
Imhoff sludge	3.88
Activated sludge	8.69
Activated sludge	9.00

The data given in Table 2 show some interesting facts. For example, the Imhoff effluent contained on an average more than 100 parts per milllion of suspended matter, whereas the effluent from the activated-sludge process contained only about 10 parts per million. The Imhoff effluent contained more free ammonia than the raw sewage, whereas the activated-sludge effluent contained only one-third as much. The Imhoff effluent contained almost as much albuminoid ammonia as the raw sewage, whereas the activated-sludge effluent contained only about one-third as much. The Imhoff effluent contained almost as much organic nitrogen as the raw sewage, whereas the activated sludge contained only one-third as much.

What became of the nitrogen carried by the sewage? Evidently most of the nitrogen in the sewage treated by the Imhoff tank passed out in the suspended and colloidal matters carried by the effluent. The activated sludge process, on the other hand, converted the free ammonia into nitrate and stored up the undissolved albuminoid ammonia and organic nitrogen, as indicated by the large amount of nitrate in the effluent and high nitrogen content of the activated sludge. In short, analyses of this material, when dry, show that activated sludge contains from 4 to 4½ per cent. of nitrogen, and sludge from certain industrial plants such as packing houses may carry even more.

Recovering the Nitrogen.

When it comes to recovering this nitrogen, however, we meet with a serious difficulty, because as the sludge gathers in the settling tanks it contains from 98 to 99 per cent. of moisture, and the bulk of this water must be removed before the dry material can be sold for fertilizer. Several methods of dewatering the sludge have been tried, such as settling, passing the mixture through centrifugal machines, pressing and drying.

The best information now available points to a combination of settling and decantation as a preliminary process. By this means the water will be cut down from about 99 to 96 per cent. On passing the concentrated residue through a press the moisture can be cut down to 75 per cent. The press cake can be dewatered in a drier to 10 per cent. of moisture or less.

More than thirty samples of activated sludge have been dewatered by sedimentation, decantation, and pressing at Milwaukee. It is an interesting and notable fact that two different types of press can handle the settled sludge without requiring the addition of lime. Many experts and manufacturers of presses have held heretofore that sewage sludge could not be pressed advantageously without lime because of the gummy or gelatinous nature of the colloids in the sludge; but the facts remain that the sludge is not as gummy as was expected, and it presses fairly easily down to 75 per cent. of moisture.

In order to try out the feasibility of further dewatering the sludge, four samples of the press cake were sent to fertilizer plants and dried there on a commercial scale. Three of these tests were made in a steam-jacketed (indirect-heat) drier and one in a semi-direct heat drier. In each case the tests proved to be successful from three standpoints: (1) The sludge dried readily to a satisfactory mechanical condition; (2) the processes did not require much power; (3) little nitrogen, if any, was driven off or lost by drying. From the mechanical standpoint, therefore, the recovery of nitrogen in sewage sludge is practicable.

Cost of Recovery.

With regard to the question of cost, however, the situation at the time of writing is not so clear. The pieces of apparatus used for settling the raw sludge and drying the press cake were not designed to handle activated sludge in the most economical manner, but were requisitioned as being the best commercial apparatus available at the time. By comparing the behavior of activated sludge with such matters as packing-house tankage the author estimates that this sludge can be dewatered so that the recovery of the nitrogen in it will probably cost, upon present evidence, about $8 to $12 per ton of material containing 10 per cent. of moisture, depending on a variety of local factors. These figures are intended to cover interest charges, depreciation, repairs and renewals, and a liberal provision for labor and fuel, as well as the cost of resettling and decanting of the water of the original sludges, and expenses for handling, freighting, and marketing the finished product. Obviously, the total cost per ton will be somewhat more in the case of a small plant than for a large one. For a very large plant, where fuel and labor are relatively cheap, it is possible that further experience will reduce the cost below the lower limit in the range here given.

The dried samples of sludge were analyzed and the data obtained are given in Table 4.

Table 4.—Analyses of Commercially Dried Activated Sludge (Basis of 10 Per Cent. Moisture).

Sample No.	Character of drier.	Per cent. of Nitrogen as ammonia.	Per cent. of Available phos. acid.
1	Semi-direct heat	4.36	0.70
2	Indirect heat	4.76	0.81
3	Indirect heat	4.56	0.47
4	Indirect heat	5.06	0.39
	Average of 4 samples	4.68	0.57

These analyses may be supplemented by the tests in Table 5.

Table 5.—Some Additional Analyses of Activated Sludge Press Cake.

Date of collection.	Per cent. of nitrogen calculated to ammonia (basis of 10 per cent moisture.)
May 3, 1916	5.74
June 20, 1916	4.65
June 13, 1916	4.88
June 14, 1916	4.92
June 16, 1916	5.01

The data obtained at Milwaukee, as cited in Tables 4 and 5, indicate that dry activated sludge (basis of 10 per cent. moisture) will contain 4.6 to 5 per cent. of nitrogen figured as ammonia and 0.6 to 0.7 per cent. of available phosphoric acid. In addition to this the Milwaukee data show that the dry product contains about ¼ to ½ per cent. of potash and from 3 to 4 per

cent. of fatty material. At present prices the nitrogen is worth $2.50 per unit (or per cent.). In normal times this nitrogen would be worth about $2 per unit. The phosphoric acid is worth about 50 cents, and the potash may be worth something in the future, although the best that can be said of it at present is that it will assure for the fertilizer a more ready sale.

The fat present in the Milwaukee sludge is neglible. It would not pay to recover the fat, nor will the fat injure the selling qualities of the dried sludge.

Value of the Product.

Summing the whole situation up, then, we see that the dried sludge has a market value upon present figures of $9 to $15 per ton of material containing 10 per cent. moisture. The total cost of getting this product and placing it on the market will probably run from $8 to $12 commercially per dry ton, depending on local conditions. For large plants this cost may possibly be reduced as a result of further experience.

The activated sludge containing 4 per cent. or more of nitrogen is much nearer a commercial possibility than the sludges obtained by the older methods of treatment, such as chemieal precipitation, septic tanks, or the Imhoff process, which data indicate to contain only 1½ to 3 per cent. of nitrogen.

In case the question arises as to the possibility of finding a market for the dried activated sludge, it should be added that raw materials containing nitrogen, phosphoric acid, and potash are capable of being worked up readily as a base for making high-grade fertilizers, and as they are not very plentiful they are in good demand. Presumably, however, large cities such as New York and Chicago, by installing this activated-sludge process, would produce so much raw material of this character that the product would have to be parceled out among a number of manufacturers. It is even possible that the production might be sufficient to reduce the price.

However, the dried sludge is a good fertilizer just as it stands, and contains enough value to pay for sale and distribution in quite a large local market. The data given indicate, therefore, that the recovery of the nitrogen in sewage sludge has at last been brought within the range of a commercially practicable problem.

Difficulties in Utilizing By-Products

THE following is a discussion to the preceding paper of Mr. W. R. Copeland, contributed by Mr. George W. Fuller, consulting engineer, of New York, in which he points out that the greatest difficulty in the way of utilizing the by-products of sewage sludge and recovering the nitrogen is the problem of dewatering. He points out that there are mechanical details yet to be studied before the process is absolutely practicable. The discussion follows:

Mr. Copeland's conservative statements on his observations at Milwaukee add materially to our practical knowledge on this subject. With the advent of the activated-sludge method of treatment it appears, in Mr. Copeland's opinion, that the handling of sludge so as to use it in a dry form as a fertilizer has now come within the range of commercial practicability. But a careful perusal of this paper indicates that he does not entertain such views concerning the sludge obtained from other processes.

Generally speaking, the data of Mr. Copeland show that dry sludge from the activated-sludge process contains about twice as much nitrogen as the sludge from other processes. His data bearing upon this matter are probably more decisive than those which have been brought together hitherto, and he explains clearly why it is that activated sludge is richer in fertilizing properties than are other sludges.

Activated Sludge Has More Nitrogen.

Experience showed years ago that plain sedimentation removes about one-third of the total organic matter in ordinary sewages and that chemical precipitation removes about one-half. That which is removed by these tankage treatments normally appears in the accumulated sludge. The balance passes out of the tank with the effluent. Table 2 of Mr. Copeland's paper shows that with the activated-sludge method the removal of organic matter is in the vicinity of 70 per cent. This seems perfectly logical in comparison with the results of plain sedimentation, owing to the fact that the activated-sludge treatment removes colloids and other nonsettling organic matters.

The data in this table further indicate that the Milwaukee Imhoff tanks, with their relatively short period of sedimentation, removed less organic matter by deposition than does plain sedimentation in larger tanks, as tested in earlier years.

When we consider the nitrogen content of Imhoff tank sludge—and the same would be roughly true for sludge of single-story septic tanks—it is necessary to recognize clearly, as pointed out by Mr. Copeland, that there is a material reduction in organic matter, due to the liquefaction and ultimate gasification of organic matters in a form permitting their direct release into the atmosphere. Obviously, septicization must mean a loss of the nitrogen content and hence of the fertilizing value of sludge.

On the other, hand, activated sludge, reinforced with the nitrogen content of colloidal and nonsettling matters, is not only spared the loss of nitrogen but is actually able to show a substantial gain in nitrogen as a result of containing some of the more or less oxidized nitrogen. The removal of free ammonia, as shown in Table 2, is quite striking. Part of it doubtless passes to nitrates, but it would be interesting to know what proportion of it becomes available for fertilizing purposes by adherence to the solid sludge as dried.

Nitrogen Contents.

Figured on a commercially dry basis (10 per cent. moisture), Mr. Copeland's average figures show a nitrogen content which is compared with some other data from activated-sludge tests, as follows:

	Per cent. Nitrogen.
Milwaukee data (Copeland)	4.40
Manchester, England (Ardern)	4.60
Salford, England (Melling)	3.75
Urbana, Ill. (Bartow)	3.5-6.4
Armour & Co. (Noble)	4.6
English range (Fowler)	4.0-6.0

Attention is called to the fact that all of the foregoing figures are expressed in terms of nitrogen and not of ammonia, as seems to be the custom in speaking of the composition of tankage from garbage works. Nitrogen is only 82 per cent. of the ammonia content,

and care must be taken in dealing with the analysis. Mention should also be made of the fact that many published analyses refer to absolutely dry sludge, whereas most of the data recently refer to commercially dry sludge with 10 per cent. of moisture.

From a commercial standpoint it is highly important to know whether the analyzed samples of sludge are representative or not of the annual output of the plant. Where sewage from a separate system of sewers is treated, this is not so vital a matter as in the instance of the sewage from combined sewers, where the amount of mineral detritus is bound to vary materially. Obviously, mineral matter dilutes the organic sludge with inert material which, pound for pound, costs as much to dry and prepare for the fertilizer trade as in the case of organic matter free of street wash and industrial wastes.

A good deal has been written, particularly in England, as to the availability of the nitrogen content as a plant food. It is not the intent to discuss that phase here, but it would appear that the activated-sludge method in this respect does not suffer by comparison with the sludge from other methods.

The availability of the nitrogen is discussed at some length in a paper by Dr. E. H. Tripp, describing the Dickson process of sludge treatment as practised at Dublin, Ireland, and printed in the Journal of the Society of Chemical Industry, May 31, 1915. In Dr. Tripp's article the nitrogen in the dry Dublin sludge is given as 2.51 and 2.26 per cent. in the two analyses published. It is interesting to note that the Dublin sludge is not nearly so rich in nitrogen as that obtained without the activated-sludge method.

Difficulty of Dewatering.

It is an altogether different matter to dewater activated sludge obtained from a settling tank in a flocculent condition and mixed with 99 per cent. of water from what is the case with Imhoff sludge containing 87 per cent. of water and mixed with gas, so distributed as to cause practically all of the solid matters to rise and allow the withdrawal of subnatant water.

Clearly the first step is to resettle and remove by decantation as much surface water as practicable, as described by Mr. Copeland. This, he says, at Milwaukee allows them to get sludge of about 96 per cent. water content. To carry this resettling too far seems to be impracticable, owing, among other things, to the fact that the activated sludge, after settling and during storage, seems to undergo putrefaction within a period of 24 hours or less. Further aeration for four or five days would make this settled sludge nonputrescible, but this treatment results in the consumption of a substantial portion of the available nitrogen.

The real problem is to dewater this resettled product. The speaker has given a good deal of attention to this matter recently, and offers comments concerning the two latter stages of dewatering, as follows:

Mr. Copeland describes the use of Worthington presses for reducing the water content from about 96 to 77 per cent. Based on general experience, it will cost for a fairly sizable plant about $3 per ton of absolutely dry solids for pressing. For commercially dry sludge with 10 per cent. moisture this figure would be about $2.70 per ton. This makes no allowances for interest, depreciation, or overhead charges.

The Dickson Yeast-Fermentation Process.

The Dickson yeast-fermentation process might allow this result to be accomplished at a much lower figure, although I am not prepared to give any cost data at present. Within the past few months I have had opportunity to investigate, in behalf of New York bankers, a test plant built in Brooklyn under the eastern end of the Williamsburg bridge for treating about 500,000 gallons of sewage per 24 hours, according to the Dickson process, which was originally installed at Dublin, Ireland. The sewage is subjected to plain sedimentation in hopper-bottom tanks, from which the sludge is removed at intervals and a portion of the water removed by further sedimentation. This sludge, with 92 to 96 per cent. of water, is mixed with about ½ per cent. of brewers' yeast and allowed to ferment for about 24 hours in long, narrow, roundbottom, sloping tanks, which are jacketed and kept heated to about 90 degrees Fahrenheit. Anaerobic bacteria decompose the yeast cells and cause the sludge to become so mixed with entrained gases that the solid matters rise to the top in a manner similar to that noted with Imhoff tank sludge, and a fairly clear subnatant water is removed through a perforated pipe at the bottom of the tank. The water content of the remaining sludge averaged about 80 per cent., according to analyses made by Hill and Ferguson, but some samples showed 75 per cent., which, with improved devices, could probably be obtained regularly.

No activated sludge has been treated at this plant, which has been shut down for several weeks pending changes. It is proposed to treat activated sludge as soon as material is obtained from the Brooklyn testing station. So far as known, there appears to be no reason why activated sludge cannot be dewatered by the yeast-fermentation process in a manner similar to that experienced with the sludge of plain sedimentation tanks, as is being installed on a large scale by Mr. Watson at Birmingham, England.

Sludge Dryers.

Mr. Copeland refers to both indirect-steam driers and direct-heat driers, with results which promise practical success for reducing the water content from about 75 to 10 per cent. Much weight should be attached to the fact that success has attended the drying of wet products in other industries, such as garbage tankage and refuse from stock yards, packing plants, etc. To drive off 4 to 6 pounds of water with 1 pound of coal seems to be attainable with the devices now on the market. Some manufacturer seem willing to guarantee a removal of 10 pounds of water for 1 pound of coal. A test guarantee of 8 pounds evaporation seems reasonable, according to the conclusions arrived at in the office of the speaker, but in practice it would probably be wise to make some allowance for waste heat, which is characteristic of all plants of this general character.

Whether or not it would be worth while to use an indirect steam drier for removing a portion of the water and then finish the drying in a direct-heat type of machine is a point perhaps worthy of discussion, and upon which the speaker has reached no final conclusion.

The drier of the Dublin type, as operated at the Willliamsburg test plant, did not prove very satisfactory in several respects. One of the principal difficulties was that the sludge contained more or less fibrous material, which formed lumps or balls which were not crushed by the stirring arrangements in this drier, with the result that they passed out through the outlet into the disintegrator. The water was not removed from the interior of these lumps as they left the drier, but were fairly well dried in the disintegrator. In the effort to dry out these lumps there were occasions when the sludge caught on fire, so that it would burn, and have its fertilizing value lessened if the fires were put out with water, which, of course, increases the amount of coal used for dewatering.

Two of the World's Largest Dams

The Elephant Butte Dam, Recently Dedicated, Stores 862 Billion Gallons of Water — The Calaveras Dam is the Largest Earthfill Structure

ON October 14 the great Elephant Butte Dam at El Paso, Texas, was formally dedicated, although it has been completed since last May. This dam was built by the United States Reclamation Service, and measured by the water it impounds, it is one of the largest in America, being second only to the famous Gatun dam at Panama. About 860,000,000,000 gallons are stored up to provide irrigation water in the Rio Grande Valley. The structure is so massive and pre-eminent that the following information, for which we are indebted to the "Engineer," is of interest:

The Reclamation Service of the United States has recently finished the dam of its great water storage project at Elephant Butte in New Mexico. The task has engaged the engineers since 1908, when tentative plans were drawn up and money appropriated for the undertaking. Actual construction work, however, was not begun until 1911, but since then it has been pushed on steadily and the dam was actually ready for the impounding of water upon May 13th last. A great deal of preliminary work was necessary before the rearing of the dam itself could be begun, and these conditions have mainly controlled the time taken to bring the project to consummation. Two thousand men have at times been employed.

Provides for Storage of Flood Waters

The irrigation plan of the Rio Grande undertaking is to provide the storage of flood waters in the reservoir controlled by Elephant Butte Dam, which is about twelve miles west of Engle, New Mexico. The

A view of the dam at Elephant Butte. It impounds 860,000,000,000 gals. of water for irrigation purposes.

waters of the Rio Grande are diverted from that river about six miles below the storage dam in order to irrigate the lands in Las Palomas Valley; about 24 miles below, for watering lands in Rincon Valley; about 60 miles below for the irrigation of 28,000 acres in the upper Mesilla Valley; about 80 miles below for the irrigation of 57,000 acres in the lower Mesilla Valley; and about 120 miles below for supplying water to lands in El Paso Valley on the Mexican side of the Rio Grande. There is a diversion dam at Leasburg in the upper Mesilla Valley and another diversion dam at Mesilla in the lower Mesilla Valley, which, of course, are subordinated to the great master dam at Elephant Butte. The Counties of Socorro, Sierra, and Dona Ana in New Mexico and El Paso in Texas are the direct beneficiaries, and a total of 185,000 acres of land will in all be brought under irrigation.

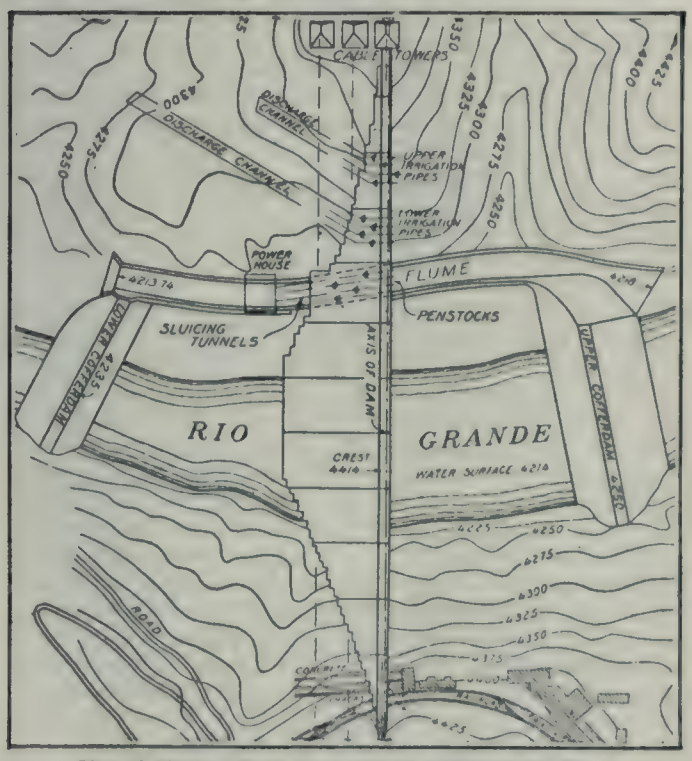
The irrigable area has a general elevation of 3,700 feet above sea level, the climate is mild, and the temperature fairly equable during the twelve months. The annual rainfall is normally in the neighborhood of 10 inches. The soils are of sandy loam and fertile alluvium, and when properly watered are capable of producing very generous crops of alfalfa, wheat, corn, fruits, melons, and vegetables. The raising of stock and the prosecution of dairying are profitable. The region offers an attractive opportunity to the industrious husbandman. The lake formed by blocking a canyon of the Rio Grande at Elephant Butte has a maximum length of 45 miles and a shore-line of something over 200 miles. The maximum depth of water near the dam is 193 feet, and the average depth is 66 feet. When full, the area of the water surface will be 42,000 acres. By means of the dam the torrential floods of the erratic Rio Grande will be controlled, and the waters impounded so that they can be fed deliberately over the entire year to the lands under cultivation. The storage capacity amounts to 862,200,000,000 gallons, or 2,642,292 acre-feet. In other words, if the water were spread out one foot deep it would cover an area of over 4,120 square miles.

Difficulties of Transportation

The town site of Elephant Butte is situated 4,220 feet above sea level, and it is above this that Elephant Butte, an extinct volcano, rises as a conspicuous landmark. One of the difficulties encountered in pushing the project to completion was that of transportation. It was necessary to tap the Atchison, Topeka and Santa Fe Railroad nearly 13 miles away, and to build a branch line having a maximum gradient of 3.7 per cent. or 1 in 27. Of this line 9.15 miles were operated by the railroad company and 3.67 miles were run by the Government. The federal authorities, however, did all the grading and track laying, but the Atchison, Topeka and Santa Fe Railroad furnished the material for the mileage operated by it. The Government portion of the route contained two trestle bridges, that at Ash Canyon, 440 feet long and 80 feet high, and that at Spring Canyon, 368 feet long and 59 feet high. By means of this line the Government was able to save in freight charges alone a matter of quite $130,000. The rolling stock consisted of four 16-ton Davenport locomotives, seventeen 60,000 lb. flat cars, forty 6-cubic yard dump cars, one derrick car, one motor car, and four push cars. The train service was maintained three days a week.

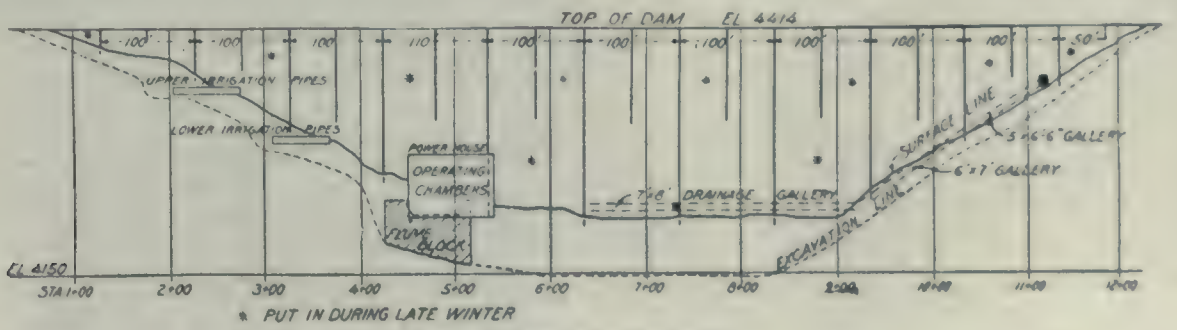
Judged by height alone, the Elephant Butte Dam is not so imposing as two of the earlier dams built by the United States Reclamation Service, but in its massiveness and in the capacity of its reservoir it is pre-eminent in America. The main structure is of

cyclopean concrete with up and down-stream faces cast against forms. The batter of the up-stream face is as 1:16. Expansion joints are placed at every 100 feet up to the elevation of 4,314 feet above sea level, and then every 50 feet up to the top. These expansion joints are of the tongue-and-groove type. The foundations were grouted 40 feet below the bottom of the dam by means of drilled holes spaced 10 feet apart from centre to centre. Drainage holes 8 in., 10 in., and 12 in. in diameter have been provided the full length of



Plan of Elephant Butte Dam, showing cofferdams and flume for diverting the river during construction.

the dam and spaced 8 feet apart, from centre to centre, in two lines. The main structure, including spillways, has a length of 1,674 feet at the top, and at that point is 203.5 feet above the original river level. The maximum elevation from the deepest excavation to the top of the parapet wall is 318 feet. The maximum width



Elevation of the Elephant Butte Dam.

at the base is 235 feet, and the roadway on top of the parapet has a width of 16 feet. There are 610,000 cubic yards of masonry in the dam, and the estimated weight of the mass is 1,000,000 tons.

Constructing the Foundation

It was necessary to divert the river through a by-pass before work on the foundation could be started. This called for a flume of concrete 1,200 feet long, 50 feet wide and 16 feet deep. Temporary dams were then laid across the river above and below the foundation site, and the work of excavation was carried on day and night until a maximum depth of 100 feet was reached below the river channel. Because of seepage it was needful to keep pumps of high capacity going steadily until the base of the dam was well above the flood point of the dangerous Rio Grande. The preliminary work required as much time as the building of the dam itself. Power for the work was supplied by three Curtis horizontal steam turbo-generators of 500 kilowatt-ampere capacity and two turbine-driven exciters of 15 kilowatt capacity. There were three circulating pumps with reciprocating engines and condensers, three reciprocating air pumps, and two duplex boiler feed pumps. Steam was supplied by four vertical water-tube boilers of 250 horse-power capacity each. All the water used had to be treated by a softening system, while stoking and the handling of ashes and coal were done mechanically. There were two complete air compressor units—each of a capacity of 600 cubic feet of free air a minute at a pressure of 100 lbs. These were driven by 100 horse-power motors. For carrying out the work of building the dam a cableway system composed of three cables of 15 tons capacity each was employed. The cableway had a span of 1,400 feet. The crushing of stone and the mixing and handling of the concrete and other materials was effected by means of electricity.

The Outlets

Water is drawn off from the reservoir by means of outlets built into the dam at three different levels. The upper irrigation pipes are the highest, at an elevation of 4,332 feet above sea level. The lower irrigation pipes are at an elevation of 4,269 feet, and the penstock intakes are at an elevation of 4231.67 feet. The sluicing tunnels are only a few feet above the river bed, which has an elevation of 4,214 feet above the sea. The sluice and penstock gates have a number of interesting features, and a good deal of careful designing was called for in planning the balanced valves for the service conduits. Taken all in all the Elephant Butte Dam is unquestionably a notable engineering achievement, and when everything is considered the total outlay of $5,000,000 is a moderate price to have been paid for the project. Potentially, benefits worth many times this sum should be reaped. Not only will the sudden torrential floods of the Rio Grande be held in check and the waters distributed when and where they will do the most good, but the ravages of this erratic river will be reduced to a minimum throughout the range of a wide area and a long distance.

One of the illustrations reproduced herewith shows the completed dam. There is a spillway on the left not shown, which is 300 feet across and is designed to pass 45,000 cubic feet per second.

The Calaveras Dam

THE highest earth-fill structure yet undertaken is the Calaveras Dam, being built to augment San Francisco's water supply. When complete it will involve over 3,000,000 cubic yards of earth fill, nearly all of which is being placed by hydraulic methods. Up to date about one-third of this has been laid. The following information regarding the design and constructional details of this work is by G. A. Elliott, in Engineering Record.

The Calaveras dam, the construction of which was begun in 1913, is located about 45 miles southeast of San Francisco and has a direct tributary drainage area of 100 square miles, which will be increased to 138 square miles by the construction of a tunnel 9,000 feet long. It will have a capacity of 162,700 acre-feet and will insure a daily supply of 57,000,000 gallons, more than doubling the present supply.

The Calaveras dam is the highest earth-fill structure yet undertaken, and in volume is second only to the Gatun dam. The height above bedrock at the centre is 240 feet, the crest length 1,300 feet, and the base width 1,300 feet. The upstream face slope is 3:1 and the downstream 2½:1. It will contain 3,084,700 cubic yards, of which 1,300,000 cubic yards are now in place. To prevent seepage under or around the structure, a trench 25 feet wide and 8 feet deep has been cut in the bedrock under the crest line. On the west side, due to the presence of seamy rock in the abutment, this trench has been carried 50 feet below the ground surface.

The reservoir outlet consists of a concrete culvert 1,300 feet long with an area of 234 square feet, following the original stream channel beneath the dam. A reinforced-concrete tower, 225 feet high, located at the up-stream end of the culvert, provides an outlet for the reservoir. The tower was designed to withstand a possible earthquake shock having an acceleration of 6 feet per second .

Designed to Resist Earthquake Shocks

The type of dam was decided upon after a thorough investigation of the foundation conditions and with due respect to the possibility of earthquake effect. Materials were available for either a concrete or an earth dam. The fault line of the earthquake of 1906 passed directly through the San Adreas and Upper Crystal Springs earth dams, and although the movement was sufficient to change the position of nearby fences more than six feet, the structures were not affected in any way. In view of this experience, it was decided that an earth structure built on liberal lines would not offer the rigid resistance to seismological disturbance that would be met in a masonry dam.

The hydraulic fill was selected on account of the economy of the method as compared to the ordinary dry fill, and also for the great advantage to be derived from the automatic selection of the material, which by this method is deposited in successive stages of quality ranging from the extremely coarse fill on the outer slopes to the fine clay in the core. Test pits indicated that workable material was available.

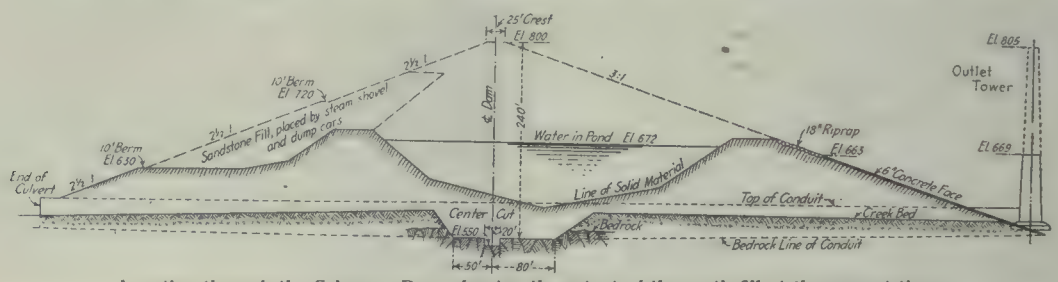
Work was started in May, 1913, and during that year the culvert was completed. Surface soil and gravel were removed to a depth of 30 feet for a distance of 65 feet on either side of the core trench, exposing the bedrock. The material removed in this way was used to build dikes along the toes of the dam to retain the sluiced fill. Early in 1914 the hydraulic fill was begun and has been carried on continuously to the present time.

Methods of Sluicing

Practically all of the hydraulic fill in the dam has been pumped. The location of only one of the eight borrowpits used was at an elevation sufficient to deliver the material by gravity. The distance of transportation has varied from 1,000 to 4,500 feet. The equipment used in the work consists of motor-driven centrifugal pumps.

At the present time two sluicing units are used. A three-stage 8-sec.-ft. centrifugal pump, direct-connected to a 500-h.p., 2200-volt induction motor running at 600 r.p.m. is mounted on a barge in the reservoir above the partly completed dam. The water is pumped through 12-inch slip-joint steel pipes, and is delivered at the pit with a nozzle pressure of 75 pounds. Hendy giants with discharge tips varying from 2½ to 4 ins. in diameter, are used on the end of the line. The size of the discharge tips varies with the material, depending upon the cutting force necessary to bring down the banks.

The second station is located in the canon below the dam and receives its supply through a suction pipe laid through the outlet culvert. This installation consists of two units, one with a capacity of 8 sec.-ft. against a 400-ft. head and one of 4 sec.-ft. against a 550-ft. head. The water from the smaller pump is delivered with a 75-lb. head and is used to cut the banks. Water from the second unit is delivered at the pit without head and simply gives a volume sufficient to carry the material to the dam. By dividing the pumping head in this way a considerable saving was effected in the power cost.



A section through the Calaveras Dam, showing the extent of the earth fill at the present time.

The jets are directed against the toe of the borrow-pit bank, which is undermined, causing it to cave in. This results in the spoil being broken up and allows the water to carry it away. The soil-laden water flows to the lowest point in the pit, passing through a grizzly or screening device made of vertical 2-inch pipe set 4 inches apart. Rocks more than 4 inches in diameter are screened out and passed through a crusher set just below the grizzly. From this point

the material is pumped by a 12-inch mud pump driven by a 300 h.p. motor through a 14-inch slip-joint steel pipe to the toe of the dam.

Controlling the Discharge

The pipes discharge their contents on the outer edges of the toes. The flow is directed toward the centre of the dam by the work of one man, who by the use of boards so controls the discharge from the pipe line as to build up small dikes along the edge of the toes. The coarser fill remains near the point of discharge, the remaining burden of the water being deposited automatically as the velocity of the stream decreases, until the pond is reached. Here the fine clay is settled in comparatively still water. The point of discharge is changed along the toes by the removal of successive pipe lengths, to maintain uniform relation between the widths of the dry banks and pond. Pipes are removed from the end of the discharge line without interruption to the pumps, so that a delivery run across the toe is always begun from the end furthest from the pit.

The mud pumps will operate against a head of 80 feet. When the head exceeds 80 feet a booster of equal capacity is cut into the line. The head on the mud pumps depends largely on the character of the soil. With an excess of clay the friction is comparatively low, and the power required is a minimum. An example of this fact may be had with the present arrangement at Calaveras. In order to reduce interruptions to a minimum, duplicate units have been installed, so that should work be discontinued for any reason the crew can be immediately moved to another location. Two pits at the same elevation and the same distance from the dam are used alternately. One of these pits is composed of about 65 per cent. clay and 35 per cent. shale rock. In the other these percentages are reversed. When using the first pit one pump is sufficient. If the second pit is used, a booster has to be cut in and the power is doubled.

Wear on Pumps

One of the problems encountered in the work was to reduce the wear on pumps and pipes. The velocity of the water and the character of material which it carries are the factors that affect the life of the carriers. Although a high velocity is desirable to secure the maximum carrying power of the water, it was found that the minimum velocity in the pipe lines which would keep the material in suspension caused the least wear on the pipes, and although the output was decreased the resulting unit cost was lower. With the installation described this critical velocity was 12 feet per second. On an average the water carries 8 per cent. of its volume of material.

All the wear takes place on the bottom third of the pipe circumference. This feature is so pronounced that the coating on the interior of the line is not disturbed on the top two-thirds of the circumference even when the plate at the bottom is worn through. High-carbon steel pipes are now being tried, and the result has justified the slight increase in initial cost. The pipes are turned twice during their life, allowing full use to be made of the metal.

The runners or impellers in the pumps are subject to excessive wear. A worn-out runner means an idle crew for half a shift while it is being replaced. Three kinds of material have been used—cast iron, cast steel and manganese steel. Manganese-steel runners cost about six times as much as cast iron; but the cost per cubic yard was cut almost in two by the use of the former. In some cases it was found that the manganese-steel runners wore unevenly, becoming unbalanced and creating excessive vibration of the pump.

The yardage handled through the life of a runner varies with the character of the material pumped. It has varied from 30,000 with sand and gravel to 200,000 with excessive clay and soft shale rock.

During the first year of sluicing the excess water in the pond was allowed to flow out through a vertical pipe in the centre leading to the culvert. To give this pipe stability a double line was used, consisting of a 16-inch pipe set inside of an 18-inch pipe, the space between the two being filled with cement grout. It was found that as the length of this pipe increased it was susceptible to the movement of the clay core, and this scheme was abandoned and the pipe filled with concrete.

Running Water From the Pond

Two trenches 4 feet wide were cut through opposite ends of the up-stream toe and bottomless flumes constructed of 1-inch boards with 4 x 6-inch posts and 2 x 4-inch spreaders. Excess water from the pond is allowed to flow out through the box which is farthest from the point where the pipes are discharging, and runs down the slope of the dam, which is riprapped up to the outlet to prevent erosion of the slope. To raise the level of the pond, rock and gravel are dropped into the cut to the required height for the width of the dry toe. The amount of clay contained in the discharge from the pond varies from 0.1 to 2 per cent. This depends on the relative amounts of material delivered, clay sometimes being wasted in order to maintain the proper relation between the dry toes and the clay core, to insure the stability of the structure.

It developed after the beginning of hydraulic operations that the available material contained in excess of clay, and that it would be necessary either to waste this excess or to add coarse material by other means. A sandstone bluff opposite the down-stream toe suggested the use of steam shovels and the deposition of this material on the outer slopes of both toes. Work was started early in 1915 with two steam shovels, the material being transported with wagons. This has resulted in a substantial increase in the width of the dry toes and has allowed sluicing to be carried on at a greater rate of speed, through eliminating the necessity for wasting in the pond discharge any of the clay core.

In order to secure storage during 1916, it was decided that, to obtain the maximum height of dam with the yardage to be deposited in the time intervening before the runoff period began, the lower toes should be moved toward the centre a distance of 150 feet. This was done, leaving a bench between the final slope location and the temporary toe, which will be filled by steam-shovel work in the sandstone. This is now being done by contract, using a Model 65 Marion shovel and 15-yard air-dump cars. The contract covers the placing of 375,000 cubic yards of sandstone, this amount contemplating a fill varying from 150 feet in thickness at the present elevation to 60 feet within 40 feet of the crest of the dam. It is the intention to continue placing sandstone on the upstream toe, unless future borrowpits develop an excess of rock and coarse material.

Tests on the Fill

Monthly tests are made of the clay core by taking samples of the fill at 10-ft. intervals. A 1½-inch pipe with a wooden plug in the lower end is forced down

to the point at which the sample is to be taken. The plug is tapped out by means of a rod put down inside of the pipe, and the plastic clay presses into the end. It is impossible for four men to force the pipe any deeper than 60 feet. At a depth of 60 feet below the pond surface a practically constant relation of 75 per cent. of clay and 25 per cent. of water by weight is found.

In addition to this quantitative test a traverse of the pond between the upper and the lower toe is also made, in order to ascertain the relative compactness of the fill. This traverse is made by forcing a pipe as far down as possible into the fill at 50-ft. intervals. The comparison between the periodical depths and distances from the edge of the pond are indicative of the consolidation of the mass.

Comparatively few men are employed on the sluicing units. Two units are working two shifts each and the total number of men per unit per shift is fifteen, making sixty altogether. When it is considered that an average of 3,600 cubic yards of material per day is transported a distance of 3,000 feet with a crew of this size, the advantage of this method of excavating and placing fills is evident. With the single exception of the relative quantity and quality of the fill, nothing is left to the judgment of the engineer.

Cost Data

The cost of excavating and placing fills by the hydraulic method depends as much on the character of the materials as on the cost of labor, material and power. The relative coarseness of the material affects the head upon the pumps. The direct cost of sluicing the first million cubic yards of fill was about 25 cents per cubic yard. This is the bare cost of the work and includes only the expense of pipes, pumps, motors, belts, power and labor used directly on the sluicing work. No interest, overhead, superintendence, insurance or the prorated auxiliary costs of clearing the reservoir site, building and maintaining roads, trails, camp, etc., are included in this figure. In this connection it must be borne in mind that the work accomplished so far has been on the base of the dam, and that as the height is increased the unit cost of placing the sluiced fill will also increase.

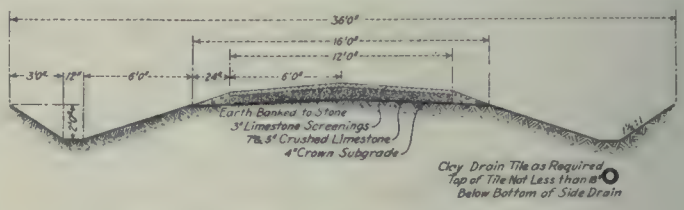
It is estimated that the dam will be completed in 1918.

A Stone Road at $3,500 to $4,500 a Mile

The illustration reproduced herewith shows the type of road being built in Adams County, Indiana, as described in Engineering Record, and which represents very cheap and yet effective construction. The funds for road construction are raised by bond issues, and as the state laws prevent a bonded debt exceeding 4 per cent. of the total assessed valuation, the cost per mile has to be kept low if roads are to be constructed over the entire township in a reasonable time. The county maintains the roads under the supervision of a highway superintendent. The maintenance fund is raised by a tax on the whole county. This fund, including automobile license fees, amounts to only $100 per mile per year, which is to take care of all repair work, including repair of sewers and culverts and weed cutting. The smallness of this fund necessitates a road in which the annual maintenance is a minimum.

The first road tried in Adams County was a 24-ft. highway, providing a 10-ft. crushed stone pavement on the right side in the direction of the heaviest traffic, and a 10-ft. earth side road. This type proved a failure, as it has been found impossible to maintain two radically different types of road on a 24-ft. subgrade. During wet or freezing weather the wheels of passing vehicles drag up mud from the earth-side road onto the stone, causing holes to "burn" through the metal. While the double track appealed to the public and is correct in theory, it has, in Indiana, proved impracticable, and in most cases the earth track is little traveled.

During the last two years the type here illustrated has been adopted. The subgrade, as shown in the drawing, can be built with the ordinary road grader pulled either by teams or farm tractor. Drainage is provided by clay drain tile laid in the centre of the side drains. All tile drains crossing the road are re-



Section of a crushed stone road built for $3,500 per mile.

placed with cast-iron sewers, with brick receivers in the side drains. These receivers are laid up in cement mortar and equipped with removable cast-iron grates. Overflow sewers are of cast iron, equipped with concrete bulkheads. All bridges and larger culverts are of reinforced concrete, and standard designs for those structures have been developed in the county engineer's office. After the completion of the subgrade the surface is thoroughly rolled with a 10-ton roller until all settlement ceases.

Upon this subgrade a course of ¾ to 2¼-in. crushed limestone, 5 in. thick at the sides and 7 in. thick at the centre, is placed to a width of 12 ft. Limestone screenings (¼ to ¾ in.) are then placed to a uniform depth of 3 in. and the metal thoroughly rolled. Ledger boards are used at the sides to hold the stone in place. Before they are removed, earth is taken from the side drains and placed against them, to hold the stone in place.

Under traffic the 12-ft. road spreads to 14 ft., and, owing to shape of the finished road surface, may be graded in and repaired without the use of new material.

Adams County has 25 miles of this type, including roads under construction, as a part of the county system of 500 miles of stone roads. Under ordinary conditions of traffic these roads will have a life of 15 to 20 years, with nominal maintenance charges.

One piece of road was built this year at a contract price of $2,629.45. The estimates were as follows: 1,321 yd. of stone complete in place, $2,443.85; grading, $350; sewers and headwalls, $115; receivers and subdrainage sewers, $42; tiling, $15; concrete culvert (8 ft. span and 26 ft. long), $322.50.

The total length of the road was 3,800 ft., or 0.72 mile. Therefore, the cost per mile would be from $3,500 to $4,500, depending on local conditions. All material was near at hand, and the longest haul was two miles.

Canadian Clay Products Convention

The next convention of the Canadian National Clay Products Association will be held at the Royal Connaught Hotel, Hamilton, Tuesday, Wednesday, and Thursday, January 23rd, 24th, and 25th, 1917.

Wooden Water Pipes

By Arthur W. Dudley*

Wooden water pipes, when encountered in street excavations, are invariably found to be entirely free from decay. These ancient pipes were bored logs, and in their manufacture the very best part of the timber —namely, the heart—was removed. It may be asked why, if wood pipe was so durable, should cast-iron or any other material be substituted? The answer to that question is that the old method of making a wood pipe limited its inside diameter to the size of the log, and therefore large pipes were both expensive and usually impracticable; 6 in. inside diameter was nearly the limit of such pipe. By the modern method of making wood pipe the diameter is practically unlimited, and it has been made in the continuous form up to 10 feet in diameter.

The two forms of wood pipe in common use are the continuous pipe, built of staves, breaking joints, put together in the trench, and what is termed "machine made." This latter is made in lengths of from 3 feet to 14 feet, and shipped to the work ready to be laid. The staves are about 2 inches in thickness, and cut true to the circle of the diameter of the pipe. These staves have two beads upon each longitudinal edge, and two corresponding grooves in the other longitudinal edge. The beads are slightly larger than the grooves, and when pressed together the bead crushes into the groove, this making it perfectly watertight. At one end there is a tenon 4 inches long where the staves are one-half the thickness of the balance of the walls of the pipe. On the other is a chamfer cut 4 inches deep. The tenon is slightly smaller in diameter at the end than at the shoulder, so that when driven into the chamfer it makes a watertight joint. These staves, cut radially to correspond with the diameter of the pipe, are held together by a steel band, either flat or round, wound spirally upon the pipe by a machine. The high tension of this band forces the beads into the grooves, making a longitudinal joint that cannot leak so long as the elastic limit of the bands is not overcome. After the pipe is wound, and the tenon and chamfer cut, it is rolled in a bath of asphalt that adheres to the outside of the steel and wood, protecting them from oxidation. Usually a second coating of asphalt is applied. It is then rolled in a bed of sawdust that forms a protection for it in shipping and handling. It is laid by driving one piece into another until the shoulders are in close contact. This form of pipe is made for diameters from 3 to 36 inches; the larger pipes are made in the continuous form.

Material in Wood Pipe

The eastern manufacturers make their pipes of the best obtainable Canadian pine. The Pacific Coast pipe is made of Douglas fir and redwood, and is banded with round steel wire, instead of flat steel, and differs also in that pipes are all made with tenon ends that are connected with sleeves, 6 to 8 inches in length. The manufacturers claim that this method of connecting gives greater strength to the pipe line, and also that Douglas fir and redwood is a stronger material than pine. The writer, however, after experimenting with both forms of pipe, came to the conclusion that, while the claim that the sleeve method of connection may be stronger, the difficulty in coating the exposed ends of these sleeves, and the fact that they would not be saturated at all times, exposed them to greater danger from decay. Also that, while Douglas fir might, and probably does, possess greater tensile and crushing strength than pine, its greater brittleness exposes it to more danger from water-hammer, and for these and other minor reasons has given the preference to the tenon and chamfer, flat-hooped pipe. This form of wood pipe was first laid in New Hampshire in 1895, at Penacook, a suburb of Concord, and this system was afterwards connected with and incorporated into the Concord water system. The Antrim water system, constructed in 1896, is a gravity system; its source of supply is some three miles from the village, and the head is slightly over 200 feet. The entire system, both supply and distribution pipes, is of wood. The writer on several occasions during the past few years has uncovered and examined pipes in this water system, and has invariably found them as perfect as when laid; the leakage here, as in all wood pipe lines that he has had to do with, is infinitesimal.

Water Systems Employing Wooden Pipe

Other water systems, most of them designed and constructed by the writer, are: (1) Campton Village, where the head is 186 feet and the supply pipe 12 inches and 10 inches; the distribution pipe, 8 inches and 6 inches in diameter; this was constructed in 1905. (2) Freedom, New Hampshire, constructed in 1912, with a head of 300 feet. Both of these systems have no apparent leaks and have cost next to nothing for repairs since their installation. Bristol, New Hampshire, has a 20-inch wood pipe supply line connecting the village distribution system with the source of supply. Laconia, New Hampshire, has a wood pipe intake line laid 400 feet into Lake Winnepesaukee, connecting with the pumping station. Hudson, New Hampshire, has an 8-inch supply line, and the writer's firm is this season constructing two water systems with wood pipe supply line, one with a four-mile distribution line, in a suburban street. The smaller system is at Troy, New Hampshire. The source of supply is a small stream that has its source in the west slope of Mount Monadnock, and this wood supply line, some four miles in length, is of 12-inch and 10-inch pipe, the head is 310 feet, the distribution system is to be cast-iron pipe. This is now in progress of construction.

Some Advantages

To sum up the situation, wood pipe has, besides the saving in cost of both pipe and installation, these advantages:—

(1) It is preserved by water, and not rusted or corroded by it.

(2) It is not corroded by any substance, or destroyed by acids or salts.

(3) Its carrying capacity is 20 per cent. greater than cast-iron pipe, and remains constant, while that of metal pipe decreases with age.

(4) It does not taint or affect fluids going through it.

(5) It does not burst if frozen, the elasticity of the wood preventing it.

(6) It requires less labor and experience to lay in place than metal pipe, and a considerable saving can be made here.

(7) It can, when service pipes are not taken off, be laid in shallower ditches than metal pipe, for it is not so easily affected by frost.

(8) In the writer's experience, while more or less joints show slight leakage when the pipe is first filled, they soon swell up and give less trouble in the end than cast-iron pipe.

*From a paper before the New England Water Works Association.

Another Fine Theatre for Montreal

Tenders have been invited for the construction of a theatre for Loew's Montreal Theatres, Ltd., on a site at the corner of St. Catherine Street West and Mansfield Street, Montreal. The site is 100 ft. by 175 ft. on Mansfield Street, with an entrance 26 ft. by 100 ft. on St. Catherine Street. The building will consist of an auditorium, mezzanine floor, and balcony, and will accommodate 1,700 people in the auditorium and 1,500 people in the balcony. Plans have been prepared by Mr. T. W. Lamb, Toronto and New York.

The theatre will be one of the finest on the continent, and is estimated to cost about $450,000. The foundations will be of concrete and the exterior of tapestry brick on a steel frame. A large amount of Missisqoui marble will be used in the stairway from the mezzanine floor to the auditorium, in the balustrade around the former, on the orchestra box fascias, orchestra columns, and in the foyer, while Caen stone cement finish is also to be extensively employed. The floors will be of concrete. The general style of decoration will be Adam. All the electric lights will be concealed in coves. The marquix over the entrances are to be of structural iron. Art glass will be used in the form of panels and also in the ceiling, and much of the plastering will be ornamental. An elaborate ventilating system is to be installed.

The entrance from St. Catherine Street is carried over a lane by means of a short bridge, and leads to the mezzanine floor, on which will be a promenade, ladies' and gentlemen's toilet rooms and rest room. Access to the auditorium from the mezzanine floor is by means of eight marble steps at the Mansfield Street entrance, where there is an inner and outer lobby and ticket and manager's offices. On the far side of the foyer, toilet and smoking rooms are provided.

Edmonton's New Pavement

A new pavement has recently been completed on Portage Avenue, Edmonton, Alta., and, inasmuch as it is one of the longest and widest paved streets of its kind in the Dominion, the following data is of interest: The avenue has a total length of 9,911 feet, or about 1¾ miles, and a total width of 100 feet. There is a 66 ft. roadway, with two 16 ft. sidewalks. The street railway tracks occupy 22 ft. at the centre. The pavement contains 55,609 square yards, with 17,444 lineal feet of curb and gutter. The concrete sidewalk amounts to 249,379 square feet. An asphaltic concrete type of surface has been used, the pavement having a 6 in. base with 2 in. bituminous surface and an additional base of 6 in. under the street railway tracks. The contractors were the International Paving Company, Crown Paving Company, and Messrs. Swanson and Kaline. The total cost was about $415,000.

Great Oil Refinery to be Built

The recent visit to Vancouver of Mr. W. M. Smith, of London, Eng., president of the famous Shell Oil Company, presages the establishment in or near Vancouver of a huge factory for the refining of oil to be brought here from the company's California wells in tank steamers. The Shell Company is the opponent of the Standard Oil Company in all parts of the world, and in California alone the company has about $35,000,000 invested in producing oil wells and other plants. Western Canada is now to be exploited in real earnest, and an expenditure of several millions of dollars is contemplated in establishing a great supply plant in British Columbia. Land has already been acquired on Lulu Island, adjoining the Fraser River, and at Barnet, on Burrard Inlet, but the exact location of the refinery has not yet been divulged because the premature announcement would cause a boom in adjoining real estate.

The Shell Company have a fleet of 86 tankers carrying oil to the vessels of the British fleet in the North Sea, and three vessels carrying gasoline and distillate from this coast to the allies in France. Their contract covers all oil and similar supplies required during the continuance of the war, which will afford some idea of the enormous deliveries being made by this great concern, whose selection of Vancouver as a supply centre for the West is an event of the first importance.

American Road Builders' Convention

The fourteenth annual convention of the American Road Builders' Asociation will be held in Mechanics' Building, Boston, Mass., during the week beginning February 5, 1917. The programme, which is in course of preparation, will include papers and discussions on subjects connected with road and bridge building and street paving by the foremost authorities of the United States and Canada.

In connection with the convention, and in the same building, will be held the Eighth National Good Roads Show. This exposition will include exhibits by leading manufacturers in the United States of the machinery and materials used in road and paving construction and maintenance.

The Coal Harbor Bridge at Vancouver

Vancouver will soon possess another handsome bridge, the city council having at last decided to proceed with the Coal Harbor causeway, which will connect Georgia Street with the northerly entrance to Stanley Park—the route taken by three-fourths of the visitors because it leads to the zoo, refreshment pavilion, recreation ground, lighthouse, and other popular resorts. Several years ago City Engineer Fellowes submitted plans for a new causeway, which met with instant approval, but the work could not then be proceeded with for financial and other reasons. Construction is now actually in progress, the M. P. Cotton Company, Ltd., having secured the contract to build the concrete retaining wall across Coal Harbor, which forms part of the design, and instal the penstocks and valves that will empty the shallow upper basin of water when desired, the tender price being $40,984.76. A temporary bridge for foot passengers has been laid, and the present bridge will be utilized by the construction gang as a working runway. The balance of the work on the new causeway will be done by the Dominion Construction Company, Ltd., their tender being for $16,962.

In memory of their son, Sergt. Louis Armour Robertson, who was killed in action on July 18, Mr. and Mrs. J. A. Robertson, Montreal, have given $200 to found a prize in the department of architecture of McGill University. Sergt. Robertson was a member of the 1915 class of architecture.

Concrete paving has often proved itself adaptable to steep grades. So far as is known, the steepest grade upon which this material has been used is in Los Angeles. Baxter Street, in this city, is paved with concrete, and the grade is in some places 29 per cent.

Noted Professor Addresses Ottawa Branch C. S. C. E.

The Ottawa branch of the Canadian Society of Civil Engineers held its first luncheon for the fall season on Thursday, October 19, at the Chateau Laurier. The Society was especially honored by having Mr. Boris Bakhmeteff address them on the subject "The Russian Engineer and the War." Mr. Bakhmeteff, who is professor of the Polytechnical Institute of Emperor Peter the Great, has been continuously on duty for over a year in New York city as engineer member of the Imperial Russian supply committee in America.

A Peculiar Bridge Failure

A highway bridge was caused to fail by collapse of the stringers due to their insecure fastening to the floor beams. A heavy traction engine in passing over the structure caused the stringers in one panel to overturn, and then collapse under the load, allowing the engine to drop through into the river. Investigation showed that the stringers, which were I-beams, were insecurely fastened to the floor beams. There was but one bolt through the flange at each end and both bolts were on the same side, thus offering very little resistance to overturning in one direction. The floor planks were laid directly on the stringers with no method of fastening. The overturning of the stringers was due in part to this condition. To prevent such failures the stringers should be fixed by both flanges and the floor planks should be nailed to furring strips attached to the stringers.

Trade Publication

The Hydrated Lime Bureau of the National Lime Manufacturers' Association has just issued a booklet entitled "Dependable Concrete—Hydrated Lime and its Effect on Workability, Segregation, Uniformity, Strength and Permeability." This pamphlet treats of the value of using hydrated lime in concrete and sets forth the several advantages which have been found by prominent engineers to follow its use in judicious quantities. There are several illustrations of jobs wherein hydrated lime has been effectively used in overcoming difficulties met in concrete construction.

Mainly Constructional

East and West—From Coast to Coast

A fair wage clause will in future be included in the contracts of the Toronto Board of Education.

The Weir Machinery Company has been incorporated with a capital of $25,000, head office at Vancouver.

The Dominion Sheet Metal and Roofing Company, Limited, has been incorporated, with a capital of $5,000, headquarters at Winnipeg.

Central Buildings, Limited, have incorporated to carry on business at Port Arthur, Ont. Capital $400,000; business will be that of general construction.

An investigation is being conducted at Ottawa, Ont., relative to a shortage of an average of five pounds per bag of cement supplied to the city under contract.

It is stated that owing to the cutting off of export of granite from Scotland on account of the war, the granite firms of St. George, N.B., are doing a capacity business.

Hon. Mr. Tessier, Minister of Roads for the Province of Quebec, recently visited Hull and the surrounding districts to inspect the road improvements already effected in that region.

The big building boom which Halifax, N.S., is enjoying at the present time manifests itself chiefly in the west end of the city, where the growth is little short of phenomenal.

Building operations are brisk in Newcastle, N.B. It is said that the town affords splendid opportunities for the erection of rentable property—houses being very much in demand.

Owing to delay in delivery of sewer pipe for the New Toronto and Mimico sewerage system, a section of the Lake Shore Road has been blocked by sewer trenches for about two months.

The Toronto Hamilton Highwawy has been completed between Hamilton and Etobicoke, thus making it a complete roadway from Hamilton to within five miles of Toronto, a total of 36 miles.

The Corbet Foundry and Machine Company, Owen Sound, have had a very busy season. Besides turning out machinery for the manufacture of munitions they shipped recently seven steel bridges to points in Ontario.

Building operations in Calgary, Alta., are now more extensive than at any time during the past two years. Contracts have been let for several large buildings, and over thirty houses are at present in course of construction.

Fifty houses are to be built in Lindsay, Ont., by a firm known as Lindsay Builders, Limited. This company has been formed with a view to relieving the housing problem, recently becoming more acute, and the fifty houses will be immediately constructed as a starter.

The Tillsonburg Foundry and Machine Company, Limited, Tillsonburg, Ont., have been incorporated to carry on the business of foundrymen, ironmongers, machinists, manufacturers of engines, motors, etc. Provisional directors are S. E. Dykeman, David J. Downs, F. J. Bushnell, S. P. Beemer and A. Sinclair, all of Tillsonburg.

A meeting was held at Cannington, Ont., recently and a good roads association for Cannington, Thorah and Brock townships was formed to work in affiliation with the Ontario County association. There is an abundance of gravel all over the county and it is proposed to utilize this material for the improvement of about 250 miles of road.

The question of the construction of a highway from Hull to Montreal, through the Labelle region, is again being taken up by the municipalities affected. The matter was placed before the provincial government in 1913, but no action was taken at that time, as there was other highway work of considerable magnitude to be completed.

Officials of the Ontario Department of Lands and Mines are making investigations regarding the deposit of iron ore which is reported to have been discovered on an uncharted island in James Bay, in order to determine its commercial value, according to a statement made by Hon. G. Howard Ferguson. The Department has received samples of the ore from this deposit, which is said to be very extensive.

When in St. John, N.B., recently, Mr. Thomas Adams, the town-planning expert, gave an address before the Rotary Club, in which he discussed the need for a comprehensive road building scheme for the province of New Brunswick, with a proper system of construction and maintenance. He recommended an independent highway commission or, as an alternative, the creation of a department of municipal affairs.

In connection with their recent extension to Granby, P.Q., the Montreal and Southern Counties Railway Company

have let a contract for the construction of a car barn at Granby West. It will be of steel, brick, and concrete, and will accommodate ten cars. The barn is to be 180 feet long, and from 30 to 60 feet wide. The superstructure will be of steel and brick, the foundations of concrete and the roof of the same material.

The good roads' movement in Ontario County, Ont., is now taking definite shape. Following the successful meeting held at Uxbridge which set the movement going, a series of meetings were arranged for at various points throughout the county and were held during the past week, their purpose being to acquaint as many as possible with the details of the scheme and gain the interest and support of the ratepayers all over the county.

The Toronto Terminals Company have suggested to the city of Toronto that the construction of the railway viaduct along the waterfront be postponed for fifteen years in order to save the expenditure of a large amount of money during war time. In the meantime as a substiute they propose to build bridges over the Yonge street and Bay street crossings, connected by a cross viaduct at the south, and also to reconstruct the York street bridge, all at their own expense.

The Dominion Fire Brick and Clay Products Company, Moose Jaw, Sask., have on foot a scheme for forming a small colony of Belgian clay workers. This company have millions of tons of fire clay on their property suitable for the making of all the most useful forms of pottery. Their idea is to gather men who will establish themselves as pottery makers, paying the company a small royalty for the clay used, the price of which will be fixed and settled before the Belgians are asked to emigrate.

The Canadian National Highway, which it is proposed to construct across Canada for vehicular travel, will extend from Halifax to Vancouver, and will pass through all the provinces except Prince Edward Island, to which, however, it will be in close proximity. It is stated that the undertaking is not so stupendous as might be expected, as it would consist to a great extent of merely linking up highways which already exist. One of the most difficult portions of the highway, from Calgary to Vancouver, a distance of 750 miles, is already to a great extent completed, only 150 miles remaining to be constructed.

Work on the Ottawa-Prescott highway, on which surveys have now been completed, is expected to commence next spring. The cost will be approximately $600,000, of which amount the city of Ottawa will pay $80,000, and each township, $3,000 per mile. A change is to be made from the original route. Instead of cutting through the township of Augusta, as was proposed, the highway will swing east, leaving the old Prescott route and running to the Johnstown road, which it will follow right down to the St. Lawrence. Then there will be a four-mile ride along the banks of the river to the town of Prescott. The route will cover a distance of about 62 miles.

The engineering work at the Whitby Hospital for the Insane which was designed by MacMullen, Riley & Durley, consulting engineers, will be carried to completion by the firm of MacMullen, Riley & Angus, who have taken over the unfinished work of the former firm. Mr. Angus, whose name appears in the new organization, is well known in engineering circles in Toronto, and has been for some years practicing his profession in this city. The new firm will continue the design of heating, ventilating, plumbing and electrical equipment of buildings as carried on by them separately in the past, and will also specialize in the building, design and equipment of industrial plants.

The first town-planning scheme to be undertaken in the Dominion will be adopted by the city of St. John, N.B., in the near future. The plan, which has been worked out with the assistance of Mr. Thomas Adams, the government expert, and is now in its final stages, will probably be made effective before winter. The area which it covers, comprises, roughly, 30 square miles, bounded on the north by the Kennebecasis, on the east by a line from Glen Falls extending across country to Anthony's Cove at Courtenay Bay, and on the west by a line from the extremity of South Bay to Taylor's Island. The scheme will for the most part consist of regulations and the laying out of the main arteries through the newly developed territory. It is proposed to regulate the width of the streets in the main portions, define the number of buildings to the acre and restrict factories, etc., to certain districts, protecting residential sections. The scheme will shortly be submitted for the approval of the attorney-general.

Personals

A. P. Kappele, works manager of Hamilton, Ont., and Controller Cooper, represented that city at the convention of the American Society of Municipal Improvements, at Newark, N.J.

Mr. E. L. Cousins, general manager of the Toronto Harbor Commission, has been asked by the Montreal Board of Commissioners, to report on the Montreal tramways problem, but owing to the pressure of work caused by the diminution of the staff owing to the war,, he has been forced to decline the offer.

Lieut. Sidney Fellowes, 39 Lowther Avenue, has been wounded in the head and back, according to a recent report. Lieut. Fellowes went overseas with the 8th Field Company of the Canadian Engineers, and has been at the front 18 months. Before enlistment he was with the Construction Supply Company, Limited, of Toronto. He is the son of Engineer Fellowes, of the Toronto waterworks department.

Lieut. J. T. Walker, a young Toronto architect, who for about four years was employed with Messrs. Darling and Pearson, and immediately before enlistment was in the educational department at the city hall, is reported missing since September 20. He fell while leading a party of bombers into a German trench on that date, but on account of the heavy fire it is stated that it was impossible to recover any of the fallen.

Mr. W. P. Kellett, of Brantford, Ont., has been made a member of the board of engineers which is soon to make a valuation of all railway properties in Canada, under the direction of the commission recently appointed to inquire into railways and transportation. Mr. Kellett was formerly chief engineer of the Lake Erie and Northern Railway which became part of the C. P. R. system, and is now connected with the Dominion Steel Products Company, Brantford.

It is understood that Mr. W. M. Ackworth, of London, England, will shortly be appointed as a member of the railroad board of inquiry in consequence of the resignation of Sir George Paish on account of ill-health. Mr. Ackworth has had extensive experience in railway matters, having been a member of several royal commissions on railway questions in Great Britain. He is also the author of several works on the railroads of the United Kingdom.

Obituary

Robert Hastwell, superintendent of the International Malleable Iron Works at Guelph, Ont., passed away recently following a short illness. Previous to coming to Guelph Mr. Hastwell was for 25 years in the employ of the Illinois Malleable Iron Works.

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The Engineer After the War

THE post-bellum period is bound to bring its problems and difficulties. That the warring nations realize this is evidenced by the very efficient preparations that the entente allies are making for the struggle that will be an aftermath of the present war—a struggle for commercial superiority and prestige, a struggle that has been characterized as the "bloodless war of the future." Economic recuperation will be a momentous problem that will require our greatest energies and our most influential efforts. But these commercial rearrangements will be largely external; they affect only our relations with outside nations and outside affairs. Readjustments, as great or greater, must be expected in the internal conditions of our nation. New situations must be prepared for and internal readjustments must be admitted if the plans for the Allies' collaboration and mutual assistance after the war are to hold. Internal disarrangements must not be allowed to render abortive the efforts that are being put forth for allied co-operation.

* * *

One great problem that will affect our country, and that is fully and clearly recognized, will be the disposal of the men back from the front. That the matter is of serious concern is realized by the efforts that our governments, our commissions, our societies and organizations, and our public men are putting forth to effect a solution. Even now, with the end of the war not yet in view, they are making preparations and urging broad schemes and suggestions. On cessation of hostilities there will be available hundreds of thousands of men of hardy physique, accustomed to open-air life and endowed with virility and eagerness. That the majority of these men will be available for hard physical work of an outdoor character is evident. The openings which these men will seek can be supplied by engineering works, by opening up railroads, roadways, and other transportation lines, by erecting buildings, and by promoting our natural resources and riches.

The financial situation will undoubtedly contribute some difficulty. Our governments will be more anxious to recuperate than to spend, but they must realize a responsibility to provide for those who have served their country. Our contemporary, "Engineering," covered the point well when it stated some time ago that "the government must afford assistance on the principle that it is better to advance loans to municipal authorities and to public corporations for the prosecution of work of a profit-yielding character than to organize benevolent schemes for the help of men and their families who are unable at once to find employment."

* * *

It is here that the engineer will have his opportunity. A broad scheme of readjustment embracing copious engineering achievements will bring the engineer into prominence as nothing else ever could. This problem of employing the skilled and unskilled labor that the battlefield and the munition factory will release will require his greatest efforts and his greatest ingenuity. The situation will be acute, no doubt, but in adjusting the country to it, it will be the engineer who will be the controlling factor. Not only in this, but in the larger plans of international co-operation which the Entente nations have formulated, opportunities are presented for the engineer to show his abilities. Much is being spoken and written to-day about the engineer's place in political life and in our governmental organizations. It has been felt that he has kept aloof too long. It is gratifying to observe that efforts are now being made to have the engineer's status recognized and to have his efforts and achievements not rendered subservient to any man. Now is the time to begin preparations for capturing the wider and more influential field that awaits the engineer after the war.

Protection from Fire Hazards

SO appalling are the number of fires each year in the United States and Canada that no effort should be spared that will help to reduce the attendant loss in life and property. Although the dangers from fire are not confined to any particular class or type of structure, yet it is in the dwellings and homes of our people, so essential to their comfort and happiness, that special means should be taken to prevent the conflagrations that too often result in fearful consequences. The home usually represents a large

proportion of the family capital, and in it are sheltered the most treasured and cherished belongings; yet, by a combination of careless construction and a lack of appreciation of fire danger, private dwellings are generally the least protected of any class of buildings. Cost apparently plays little part. As a rule, the most ostentatious palace is as defectively constructed and as flagrantly liable to destruction as the most modest cottage.

The lack of even the most elementary forms of protection is almost incomprehensible when a little thought and investigation show that the danger can be largely eliminated by very simple precautions. City ordinances and municipal building codes may improve conditions, but they place comparatively little restriction upon the construction of dwellings, and are usually not sufficiently explicit to be of much real service. Besides, a large proportion of dwellings are located in suburban or rural districts beyond the jurisdiction of city by-laws. It is thus only by an educative campaign and by enlightening public sentiment that much can be done in reducing the fire hazard among residences.

With this object the National Board of Fire Underwriters have recently published a booklet entitled, "Dwelling Houses—A Code of Suggestions for Construction and Fire Protection," the principal purpose of which is to issue warnings against prevalent dwelling house fire hazards and to indicate how they may be avoided. It deals only with construction which influences the spread of fire. The subjects of design, costs, and suitability of materials are avoided, except so far as they are necessary incidents to the discussion of general fire resistive features and good construction. The majority of suggestions are applicable to all types of dwellings, but it is certain that one of their greatest fields of usefulness would be in connection with the vast number of unpretentious dwellings which lie outside of any municipal limits. This pamphlet is distinctly educational in character, since there is no authority to enforce its provisions. The aim has been to recommend the most efficient and practical methods of fire protection, to warn against unsafe construction customs, and to urge best structural practice generally.

The suggestions are incorporated in specification form, and cover every portion of dwelling construction that is subject to fire destruction or loss. That the subject is treated very comprehensively is indicated by the scope of the contents: Quality of materials suitable for construction work; walls; floor and roof construction; major structural requirements to protect life and prevent spread of fire; chimneys, flues, smoke-pipes, and fireplaces; heating and lighting equipment; fire-stopping; frame dwellings; concrete construction; general precautions for fire protection.

It is pointed out that there is a prevailing belief that incombustible dwellings are impracticable because of the excessive cost. As a matter of fact, this opinion is not justified, for numerous dwellings of this class are being erected in different parts of the country at costs not exceeding 10 to 15 per cent. over that of first-class combustible construction. Reputable contractors claim that in some localities the difference in cost is even less than this. If properly designed, such buildings not only furnish complete safety to the occupants, but reduce to a minimum the danger of a complete burn-out from an interior fire, and greatly lessen the hazard of ignition from burning of neighboring buildings. They are also rat and mouse proof, as well as having increased sanitary advantages.

The cost of structural fire barriers necessary for reasonable protection to a dwelling house amounts to but a small percentage of the total cost of a building. For this reason it is hoped that architects and owners will adopt them once their attention is directed to the reduced hazard resulting from a little intelligent thought and care. Speculative builders who erect houses to sell, and build them as cheaply as possible, with slight regard to utility, will perhaps be disinclined to adopt alterations which will add anything to the cost. However, even these should be convinced of the advantage gained as an advertising medium by the introduction of such structural safety features. It is reasonable to assume that a prospective home purchaser would be very favorably impressed with the idea of buying a house in which all precautions had been taken against the spread of fire.

New Water Supply for Vancouver

The superb quality of the water furnished Vancouver citizens is commented upon in terms of admiration by every visitor and tourist. Many globe-trotters have declared that no city in the world has water of equal purity, and that in this great possession the people have an asset the worth of which is simply inestimable. This is realized by a majority of the citizens, perhaps, but they take it as a matter of course, instead of proclaiming it a unique gift of nature. Certain it is that the remarkable immunity from certain diseases and the very low Vancouver death rate may fairly be ascribed to the excellence of the city's drinking supply, and this alone is sufficient to attract new population.

The city's supply comes from the Capilano and Seymour systems, having their sources in the mountains of North Vancouver, the water coming from glacial streams. Until recently the larger portion of the city's daily consumption of about 18,000,000 gallons (in hot weather) came from the Seymour system, but a third 18-inch steel main is now in place under the First Narrows, and supplies 3,000,000 additional gallons per day of Capilano water, or approximately 9,750,000 gallons, a quantity slightly in excess of that received from Seymour Creek through service pipes crossing the harbor at Second Narrows.

The new main, which represents an outlay of about $14,000, was recently brought into service by Mayor McBeath, who took occasion to compliment City Engineer Fellowes on the very successful way in which the work had been carried out. When the big valve on the north shore was opened the pressure gauge registered 176 pounds, and a similar test made at Stanley Park, on the south side of the harbor, and at a considerably higher elevation, gave a steady pressure of 151 pounds.

Besides the three 18-inch flexible joint steel mains now in commission at First Narrows there are two unused 12-inch mains in position, which can be connected up when desired, and thus furnish the equivalent of another 18-inch main, which would bring the total daily supply from the Capilano system to nearly 13,000,000 gallons.

Of interest to municipal authorities is the unique manner employed by a New Jersey city for exterminating mosquitoes. It reads something like fiction, but at any rate the information is official, being contained in the 1916 year book of the city in question. The residents had for some time been pestered and tormented by the mosquitoes which, it was learned upon investigation, were propagated in stagnant pools in a certain district. It was found practically impossible to drain these to the street gutters and as some other method had to be devised it was decided to sink the water into the ground. A heavy charge of dynamite was sunk and discharged about 20 feet under the surface. This caused the pools to disappear entirely and no water has since accumulated.

Public Service for the Engineer*

THE engineer, above all others, will be called upon in the solution of big public problems and in the development of governmental administration, as he has been in the solution of military and industrial problems. In the military service the engineer is called upon to reconnoitre and develop offensive and defensive engineering plans for the fighting forces and fighting machinery. Upon the engineer corps the duty of arranging for the sanitation of the camp and for comfort and health of the military organization is placed. The engineer has been called upon to lead in the solution of problems of transportation.

To engineers credit must be given for the great achievements in connection with the construction of railways and waterways, the construction and operation of our municipal and other public works, the extension of public improvements, and in the development of economic and scientific methods in the conduct of the routine of public administration. The role, which the engineer has played in the administration of affairs of our governmental bodies, has been mostly that of close application to details of administration, the importance of which have not always been brought out or fully appreciated by the public. In spite of these handicaps and the restrictions ofttimes brought about by politics and the uninformed and misinformed officials, the engineer has brought into the civil service the spirit of workmanship and ideals of scientific management, and has been the first to use and instill in the minds of others the necessity of management based on scientific method.

Opportunity for Engineers in Public Administration.

In making any statements of achievements already accomplished through the patriotic and unselfish services of engineers, I was not unmindful of the greater opportunities which are before engineers and other trained personnel in the further development of responsible and effective public administration. Engineers, because of their analytical training, their ability to obtain and stick to facts and to act with precision, their imagination and vision for new and big things, and their genuine interest and spirit of public service, have in the public service almost a virgin field.

The entry into the public service of men and women of ability and sincerity of purpose, with high ideals and non-recognition of the negative things in the public service, will have the effect of bringing about positive and fundamental improvements in the administration of public affairs and will give further impetus to the increasing favorable attitude of the public toward governmental administration. Politics, incompetency, irresponsible, and mediocre service and administration can find no comfort and cannot long survive where such conditions exist.

Variety of Problems Confronting Municipalities.

It would not be possible within the confines of this paper to go into detail on the diversity and complexity of the problems confronting our municipalities, nor of their growing importance. A mention of some of the more important technical divisions indicates the field and broad opportunities and urgency for a trained personnel in the municipal service:

1. Finance administration and municipal accounting.
2. Taxation, budget making, and municipal financing.
3. Municipal reports, publicity, and statistics.
4. Technique of constructive investigation and reporting.
5. Civil service administration and standardization of employment.
6. Standardization and centralization of purchasing and testing.
7. Management and administrative procedure—scientific management.
8. Education administration.
9. Public health administrtaion.
10. Justice, charity, and correction administration.
11. Social surveys—housing.
12. City planning.
13. Police and fire administration.
14. Public works administration and local improvements.
15. Water supply administration.
16. Municipal lighting.
17. Pavement construction and repair.
18. Cleaning of streets and removal of snow.
19. Sewerage systems and sewage disposal.
20. Collection and disposal of city wastes.
21. Parks and playgrounds and recreation administration.
22. Elimination of smoke nuisances.
23. Regulation of local public utility rates and services.
24. Street railways, elevated roads, and subways.

City Manager Government.

Within the last two years over eighty of the municipalities in the United States have adopted the city manager form, and there seems to be no sign of abatement in this direction. These commission-manager cities are scattered through twenty-eight states.

Hon. Henry Waite, city manager of Dayton, which, by the way, is the largest city that has adopted the city manager plan of government, outlines the advantages of the city manager form of municipal government, as follows:

1. Simplicity.
2. Basis of organization—efficiency and economy.
3. Centralized authority.
4. Fixed definite responsibility.
5. Business methods.
6. Prompt and effective action.
7. Employment of experts when needed.
8. Commissioners represent the whole city, not ward.
9. Interests a higher type of man in city service.
10. The short, non-partisan ballot.
11. Abolishes politics from the administration end of government.
12. Separates the legislation from the administration.
13. Does not depend on ballot to select trained men for particular functions of government.

These problems of public service which are presented by the new order of things are being recognized by a growing proportion of our people. This is shown by the new civic spirit which has arisen in our municipali-

* From an address by J. L. Jacobs to the Western Society of Engineers.

ties and the attitude of the increasing number to serve as watchful and informed citizens, or as agents to carry out the affairs of government in a way such as to raise the horizon of civic and community service.

Growing Activities and Organizations.

The field of public service which is performed by these citizen agencies has increased with the growth of the functions of government. Opportunities are not only offered for work in these organizations, but governmental officials have turned to them for men and women to fill official positions requiring training and experience of public administrative problems and the knowledge of the structure and operations of government. Increasing activities and co-operation of these civic agencies with governmental bodies is bound to create a further demand for trained workers in public administration. The more important organizations and associations, which have been developed and are active in this positive and growing field, are the following:

Ballot associations.
Boards of trade.
Bureaus of municipal research.
Chambers of commerce.
City clubs.
Civil service reform associations.
Commercial clubs.
Educational associations.
Foundations for special research.
Health associations.
Housing reform associations.
Industrial associations.
Juvenile associations.
Legal aid associations.
Legislative leagues.
Local improvement associations.
Merchants' associations.
Municipal leagues.
Real estate associations.
Recreation associations.
Tax associations.
Training schools for public service.

Opportunities in the civil service are increasing faster than the supply of men and women who are trained and interested in the public service. Steps must be taken for thorough and sustained practical preparation for public service administration. The creation of a larger supply of men and women who are trained and are genuinely interested in public affairs and wish to find a career in the official life will go very far towards stimulating further demand for experts. This, I believe, will largely solve our problem of efficient and responsible public administration. There have been a number of suggestions and programmes set out for developing such a trained army of civil servants. In the adoption of the following steps there lay the solution for preparedness and increased opportunities in our public service

1. Publicity of public administration and of researches on government and public administration.

2. Extension of merit system and positive employment methods and control.

3. Practical training for public service in connection with our educational programmes and with civil service administration.

4. Federal enactment for the promotion of public service training and distribution of federal appropriations amongst individual states and cities on uniform basis.

5. Co-operation between administrative departments of the federal government, states and cities and our state and other educational institutions, providing for practical training and field work in public service.

6. Encouragement of training of public service to teachers and compulsory instruction of principles of democracy and public administration to children and immigrants.

7. Recognition of public service as a profession of dignity, social prestige and permanence.

The Merits of Concrete Pavements

THAT the concrete road will be the ideal road of the future, as it is the ideal road of to-day, is the statement made by Edward N. Hines, chairman of the Board of County Road Commissioners, Wayne County, Michigan, before the meeting of the Portland Cement Association in Detroit. Mr. Hines says that any community desirous of improving a road upon which there is a present or prospective daily average mixed traffic of 200 or more vehicles is justified in expending a sufficient sum of money to build a first-class concrete road. Traffic is always much heavier after improving a road than it was before improvement. Sometimes it increases out of all proportion to the volume estimated. Over a period of years concrete is the cheapest good road that can be bought, figuring cost as an annual proposition, which is the correct way to figure it, rather than to figure from the standpoint of first cost. The fact that a concrete road is free from excessive yearly maintenance charges, is extremely durable, usable throughout the entire year by all types of vehicles, irrespective of weather conditions, warrants its construction regardless of first cost.

The question of cost is largely a local question, and is affected by the thickness and width of the road, length of haul, cost of materials on board cars, freight charges, availability of side tracks for unloading, cost of teams, availability of labor-saving equipment, cost of labor, distance, elevation, and source of water supply, amount of skill and experience demanded in finishing, length of time road is given to harden properly, conditions of subgrade over which materials are hauled, weather conditions, and numerous other factors. In many instances it is compared with the cost of concrete foundations such as used under other types of construction. This is an unfortunate fallacy, as the specifications and practice governing concrete foundations for other surfacing materials are widely different from specifications of the all-concrete road. It is also a mistake, in Mr. Hines' judgment, to dig out some unusually low cost concrete road where all conditions were nearly ideal and present it as an example of fair cost. In an endeavor to duplicate such a cost, many a concrete road job has been let to well-meaning but ignorant contractors, and the road has suffered in consequence, because the contractor, being only human, feels that the community is better able to stand the loss than he, if loss there is to be.

You do not spend any stated sum for a concrete road—you **invest** that stated sum; and it will pay any

community handsome dividends in the way of decreased hauling costs through ability to move larger loads and move them in less time. It will pay dividends in decreased repair and upkeep bills on harness, wagons, and automobiles, in prolonging the lives of horses, in increasing mileage of rubber tires, in increasing mileage on a given amount of gasoline consumption, in increased land values, and in a sum total of pleasure and satisfaction that cannot be expressed in dollars and cents. The low relative cost of a good concrete road compared with other forms of construction often raises the presumption that it cannot be as good or it would not cost so much less. Furthermore, the cost in one locality has no bearing on what it may cost elsewhere unless all local conditions are taken into consideration.

Maintenance should be built into the road, which means building it of hard, tough, clean aggregates of uniform quality and correctly combined with a proper amount of cement thoroughly mixed, placed, and cured. In the case of first-class roads, $30 to $50 per mile for labor and material has maintained the surface.

As far as cracks are concerned, Mr. Hines declares that although cracks are not assets of a concrete road, and every effort should be made to prevent them by using good materials and a high grade of workmanship, nevertheless some cracks are likely to occur. Adverse criticism of certain concrete roads has been widely circulated, in which cracks are exaggerated in number and size, and so described as to lead one to think that the road has been ruined, if not completely destroyed. In many instances the wish is father to the thought. Expansion joints are spaced at regular intervals, and cracks, when they do occur, are cheaply and easily taken care of by a maintenance system involving the use of tar and coarse sand. Such cracks do not militate against nor interfere with the use of the road by traffic. It is true that the black streak made by the tar-and-sand preparation used to maintain cracks does not tend to improve the appearance of the otherwise gray surface of a concrete road, but if the surface is smooth, free from ruts, holes, bumps, and dust, and usable any day in the year, irrespective of weather conditions, cracks should not be seriously regarded.

Traffic Increases After Improvement.

In discussing width, the writer said that his experience has been that as soon as a concrete road is opened, traffic on it increased at a wonderful rate compared with what the road carried before improvement. Not only is an increased use of the road made by those living along it, but by people who come miles from all directions to use the concrete in preference to the routes they have formerly traveled; hence, a concrete road must be built not only with a view to accommodating the traffic it has been accustomed to bear, but a traffic at least three times as great. Within his own personal experience he had seen traffic increase twenty-fold in two years' time after a road had been concreted.

Remembering that an improved road attracts an increased traffic, and that the tendency of traffic is toward greater speed, wider gauge and heavier loads, Mr. Hines believes that a concrete road built in proximity to large centres of population should have a minimum pavement width of 24 feet; 18 feet should be the minimum for a safe two-track road; and where, for financial reasons, single-track roads must be built, 10 feet should be the minimum. His personal view is that no concrete road should be as narrow as 9 feet. Where, for the reasons mentioned, a 10-foot concrete road is built, he is in favor of letting one edge of the road fall along the centre line of the highway, sloping the pavement one way, with the idea of simplifying the construction problem of widening the pavement in case the necessary funds become available and conditions demand the improvement.

The speaker drew attention to the fact that a good concrete road does not mean higher taxes, but more value to tax. It has invariably increased the valuation of surrounding properties, and the increased revenue thereon will in time pay off the original cost of construction and maintain a high standard of excellence.

In conclusion, Mr. Hines pointed out that there is a factor which he regards as necessary to making the concrete road the ideal all-round road. That is, a surface must be produced that is absolutely free from any waves, depressions, or irregularities of any kind. Being a plastic material, concrete easily lends itself to securing such results. It is purely a question of good workmanship. When the quantity of the work is sufficient to warrant its use, the finishing machine, by eliminating the human equation, will bring about the desired results more rapidly than they may be secured through perfecting the "art" of concrete road building. The finishing machine also permits placing mixed materials in a dryer state, and, through its ability to thoroughly compact the concrete, will give a greater density. There is no financial saving in the use of a finishing machine, but there is a decided gain in the quality of the finished road. Water pockets and air bubbles are eliminated. A more homogeneous concrete is secured. If side forms are firmly staked to line and grade, results secured by using a finishing machine cannot be attained in any other manner.

With changing traffic conditions due to the automobile and motor truck, greater weights and greater speeds of modern traffic, the modern road must, if it is to give service and satisfaction, be built rigid—road shocks must be taken up by springs, pneumatic or cushion tires, or other means.

November Meeting of the Toronto Branch C. S. C. E.

The regular monthly meeting of the Toronto branch of the Canadian Society of Civil Engineers will be held in the society's rooms at the Engineers' Club, 90 King Street West, on Thursday, November 9th, at 8 p.m. Mr. William Storrie, A.M. Inst. C.E., will give an illustrated address on "The Drifting Sand Water Purification Plant for the City of Toronto." Mr. William Gore, M. Inst. C.E., the inventor of the system, will be present and will take part in the discussion.

C. S. C. E. Montreal

Three addresses on military subjects were given at the opening meeting of the 1916-17 season of the Canadian Society of Civil Engineers, Montreal, on Oct. 5. Lieut. Paul Ogilvy, B.Sc., late of Lieut.-Col. Ramsay's Railway Construction Corps and now with the 242nd Forestry Battalion, described the construction of certain military railways at the front, alluding to the difficulties under which the work was carried out and the value of the lines. Capt. J. G. Ross, B.Sc., 13th Battalion, Royal Canadian Highlanders, spoke on machine guns, and vividly described the fighting on the Ypres salient. Mr. W. J. Francis, by means of diagrams, gave a description of the now famous "tanks" which caused so much destruction in recent fighting.

The Construction of Concrete Pile Railway Trestles

By I. C. Crawford, C.E.*

THE concrete pile railway trestle, which is rapidly replacing the timber trestle, is composed of three distinct parts: (1) the concrete piles; (2) the concrete caps in which the concrete pile heads are imbedded; and (3) the concrete slabs extending from cap to cap on which the ballast and track rest.

The object of this article is to describe the general method of constructing these trestles as followed by the Illinois Central Railroad. All plans reproduced here are taken from the standards of this road.

Laying Out the Bridge

The first step in laying out a bridge is to definitely locate the positions of the different bents. In many cases the timber bridge, which is being replaced, may have been renewed three or four times, and on each occasion the bents driven in a different location. A sharp lookout should be kept for these old pile studs so that the new bents may not be located on top of them. Unfortunately these stubs, with sometimes a cap on them, may be entirely covered. Usually, a

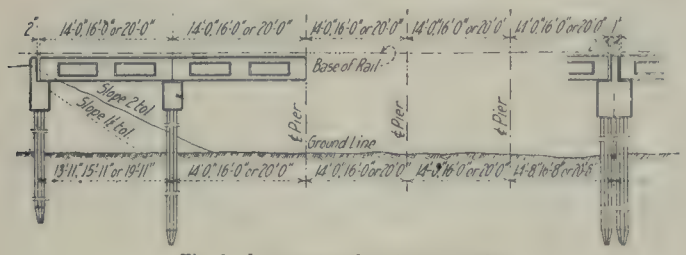


Fig. 1—A concrete pile railway trestle.

piece of the old cross-brace will project above the surface of the ground, showing the location of the old bent.

After the bents have been located the points for the piles in each bent may be set. This may be done in the following manner: A straight-edge, fourteen or fifteen feet long, is placed at right angles to the track and on the centre line of the bent. The centre line of track bisects the straight-edge, which is squared by means of a carpenter's square and the rails. The positions of the piles of the bent are then marked on the straight-edge and their positions on the ground found by plumbing down from it.

Classification and Construction of Piles

Concrete piles may be divided into two general classes. The first class includes those piles which are cast in forms and, after having been allowed to cure for a certain length of time, are jetted or driven into place. The second class consists of piles which are poured in place. In this process a hole is bored into the earth and filled with concrete, the concrete being supported by steel forms or by the earth alone. The following discussion deals only with piles of the first class.

Piles of the first class, or pre-moulded concrete piles, are usually square, round or octagonal in cross-section. Fig. 2 shows cross-sections and longitudinal sections of an octagonal pile used extensively by the Illinois Central Railroad. As shown in the figure, the area of the longitudinal reinforcement varies with the length of the pile. It will also be noticed that the longitudinal rods are brought together near the point of the pile and are wrapped with No. 12 wire. The hoops are made of No. 7 wire and are welded. The piles are made in lengths varying from twelve to forty feet. A 1:2:4 mixture is generally used in the manufacture of concrete piles.

Unloading and Driving

In unloading from the car the pile should be picked up at its centre and handled carefully as the point is easily broken off by a side blow. A convenient sling for use in this work is made from two thicknesses of ¾-inch steel cable. Foresight should be employed in choosing the unloading place so that when driving operations start the piles will be conveniently located.

Either a steam or a drop hammer may be employed in driving the piles. The steam hammer is the more frequently used and with it a device for distributing the blow evenly over the head of the pile. This device is known as the pile bonnet or cap and varies considerably in form and dimensions. A sketch of a pile cap used by the Illinois Central Railroad is shown in Fig. 2. The hammer strikes upon a steel plate fastened to the upper end of an oak or beechwood follower which is placed in the bonnet. Below the follower, eight to twelve inches of coiled rope is placed in the bonnet. This rope serves as a cushion and distributes the blow evenly over the head of the pile. In this particular case the follower is about fifty inches long. This allows a pile to be driven several feet below the top of the ties without dropping the leads down with it. The condition of the rope cushion should be carefully watched and a fresh coil inserted when the old packing becomes too hard, since in this condition the cushion may cause the pile head to spall.

Placing the Piles

The first step to be taken in the driving operation is to pick up the pile and hoist it into the perpendicular position in front of the leads of the driver. In doing this the sling should be placed around the pile about four feet from the top end and the pile line hooked into the sling. A hand line should be attached to the lower end of the pile to control its motion and thus prevent accidents which are often caused by the pile swinging into the bridge as it is being elevated.

The second step is to land the pile on the exact spot where it is to be driven and to place the hammer and bonnet on it. The driver, carrying the pile in front of the leads, is run slowly out on the bridge and stopped at the proper place; the pile is lowered, correctly centered, and, in case it is square or octagonal in cross-section, is squared with the centre line of the track. The pile is then approximately plumbed, the leads moved into place and the hammer lowered until the top of the pile is engaged in the bonnet. The weight of the hammer is not, as yet, allowed to rest on the pile.

The third step is to plumb the pile, land the hammer and then to drive the pile, keeping it in a truly vertical position all the while. The pile is plumbed in

* In the University of Colorado Journal of Engineering.

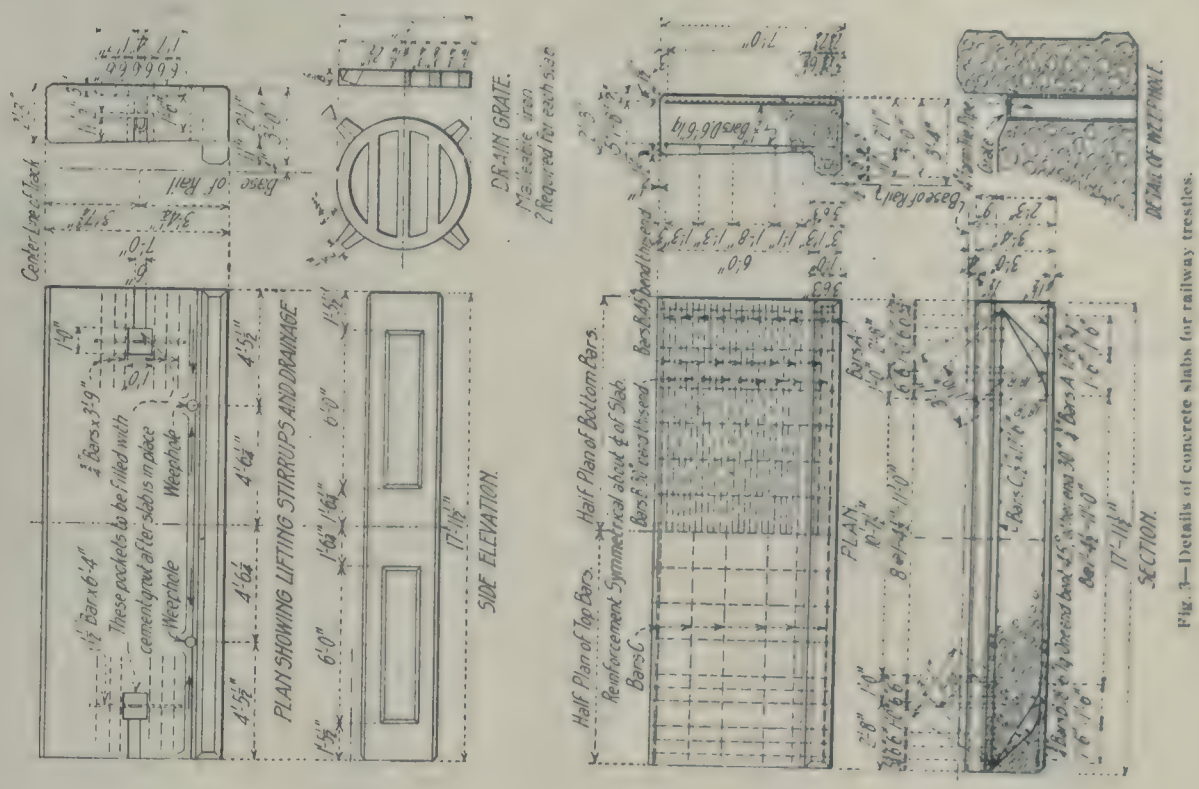


Fig. 3—Details of concrete slabs for railway trestles.

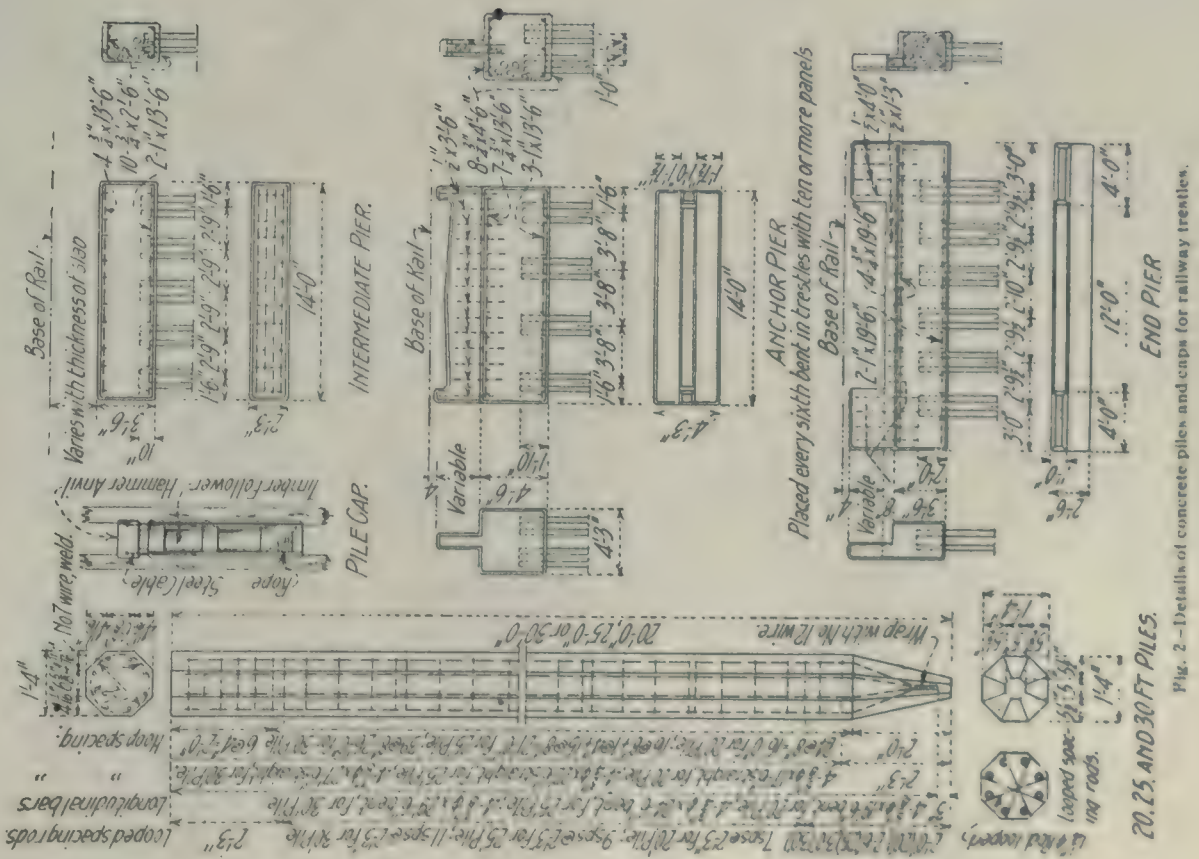


Fig. 2—Details of concrete piles and caps for railway trestles.

a direction perpendicular to the track by swinging the leads across the track and by inserting blocking between the rails and the pile or the leads. It is plumbed parallel to the track by attaching blocks and tackle to the leads in front and then to the rails or ties, and by attaching a block to the back of the leads, the block having a rope running through it, each end of which is wrapped around a nigger-head on the engine. Thus the leads, with the pile, may be pulled backwards or forwards parallel to the centre line of the track.

Alignment Must Be Maintained

After the pile has been accurately plumbed the weight of the hammer and bonnet is allowed to come on the head and driving starts. During the first few feet of penetration it is necessary to watch the pile closely from both directions so that any departure from the vertical may be noticed and promptly corrected.

When a penetration of twelve to fifteen feet has been secured the above methods of plumbing should be used with caution since heavy bending stresses will be produced in the pile and may cause it to fail. It is sometimes possible to straighten a pile at this depth, by slanting the leads and allowing the hammer to strike the side of the pile head opposite the direction in which the pile is to be straightened. Here again judgment must be used since too many blows applied in this manner will spall the head of the pile.

The point to be emphasized here is: the pile should be perfectly plumbed before driving is started and it should be closely watched for the first ten or twelve feet of its penetration so that a variation from the perpendicular will be immediately observed and corrected.

It is necessary that the centres of the pile heads in a bent be very nearly in a straight line, this line being the centre line of the bent. When the work is carefully done the pile centres need not vary more than two and one-half inches from the centre line, while a large percentage of them will probably have a variation of less than one and one-half inches. Occasionally a pile will "get away" making it necessary to design a special cap for the bent.

Good practice demands that the pile should have a penetration of at least fifteen feet. Where the ground is exceptionally hard it will be found impracticable to secure this penetration, and in case the ground is soft it will be necessary to drive the pile to a greater depth. The Illinois Central Railroad issues rules for the guidance of its inspectors which require that: (1) all piles must be given a minimum penetration of fifteen feet whenever possible; (2) in case a pile has been driven ten feet and it has taken 600 blows of the hammer to secure the last foot, the driving may be stopped at that penetration; (3) on the other hand, in case a pile has received a penetration of fifteen feet and is sustaining less than 150 blows per foot of penetration, driving must be continued until this number is sustained.

Penetration in Soft Ground

In very soft ground it will often be necessary to drive piles to a penetration of twenty-five feet or more. Sometimes when a pile is driven within about two feet of the proper elevation and allowed to rest for a day or two it will be found that several times the number of blows will be required to drive the remaining distance, than would be expected.

A pile may be cut off at any desired elevation by chiselling through the reinforcement and then attaching the pile line to the reinforcement and pulling it out. It will, of course, be necessary to pass the pile line under a cap or stringer so that a horizontal pull is given.

The number of piles which can be driven in a day depends upon several factors. If a bridge is located on a busy single track line much time will be lost in running to and from passing tracks. The distance to the passing track will influence the number of piles which can be driven. Should it be necessary to move the stringers before piles can be driven, and it usually is, more time will be lost. Under ordinary single track conditions the driving of eight or ten piles makes a fair day's work.

Caps and Slabs

As soon as all the piles in a bent have been driven, work may be started upon the forms for the cap. As shown in Fig. 2, the pile heads project into the cap a distance varying from ten inches to two feet. The floor of the form is cut to fit around the heads of the piles, and is wedged up to the proper elevation. A good foundation for the form may be made from a couple of old bridge stringers, one placed on each side of the bent. The ends of the forms, parallel to the centre line of the track, should be carefully lined and if the bridge is a long one it is necessary to use a transit. A hub may be set at each end of the bridge on a line perpendicular to the centre line of the track and a distance equal to one-half the length of the cap from it. The line joining the points of the two hubs will give the ends of the caps. The bottom of the cap forms may be kept at the proper elevation by means of wedges.

Three different styles of caps may be used in the same bridge, as shown in Fig. 2. Anchor bents are used only in bridges having eight or more panels. It will be noticed that the anchor bent for single track has two rows of piles and four piles in each row. The number of piles in the end bents varies with the height of the fill, the usual number being six. Intermediate single track bents have five piles as shown in Fig. 2. The spacings of the piles are shown in the cuts.

The details of the slab used are shown in Fig. 3. These slabs extend from cap to cap, there being two slabs in each panel for single track work and four for double track. The slabs are handled by a derrick and are raised by means of the lifting hooks imbedded in the slab as shown in Fig. 3. It is the usual practice to build these slabs at centrally located points and to ship them to the various bridges as needed. They are built for fourteen, sixteen, and twenty-foot panels. All slabs are seven feet in width.

In the construction of caps and slabs a 1:2:4 crushed stone concrete is used.

In an effort to foster manufacturing industries Vancouver City Council will probably give free water to plants employing a minimum number of workmen. The city can well afford to do this, last year's net revenue from the waterworks department having been about $80,076, which includes about $40,000 owing in meter rentals. The cost per 100 cubic feet of water was 4.1 cents.

The Montreal Machinery and Supplies, Ltd., have opened an office at Room 504, McGill Building, Montreal, for the sale of machinery, machine tools, and various supplies used by contractors, manufacturing plants, railroad shops, etc. Mr. J. E. Ryan is the sales manager.

Service Pipes for Waterworks Use

The Relative Values of Various Materials Employed in the Manufacture of Water Supply Lines

AT the recent annual convention of the New England Waterworks Association the committee on service pipes presented a report, through its chairman, Mr. W. S. Johnson, incorporating the results of investigations made to determine the relative values of various materials used in the manufacture of service pipes. This subject has not received a great deal of attention and yet its importance is so obvious that the report reproduced below in extracted form is not out of place. It concerns itself with practical data, collected through the co-operation of waterworks men. It is called a preliminary report, since it is felt that a general discussion should be inaugurated before a final or complete report is formed.

The committee on service pipes began its investigations by sending to every water department in New England requests for information relating to the materials used in service-pipe construction, the troubles experienced, and other matters which appeared to be of interest in this connection. Over 300 replies were received. To have matters further explained, at two meetings of the committee a number of superintendents who appeared to have had exceptional opportunities to obtain valuable experience were questioned in regard to the details of their practice and experience.

In considering the information contained in the replies received it should be understood that the returns from New England included a large number of small places, while the 56 replies from outside of this district were chiefly confined to larger communities.

The returns in regard to the material now used for new services may be summarized as follows: Wrought iron or steel, 13; galvanized iron, 145; lead, 48; lead lined, 13; cement lined, 37; galvanized and lead, 14; galvanized and cement lined, 4; galvanized, lead, and cement lined, 2; galvanized and lead lined, 10; iron and cement lined, 2; cement lined and lead lined, 1; cement lined and lead, 2; lead and lead lined, 4; lead and wrought iron, 3; miscellaneous, 6; total, 304.

Materials Used for Service Pipes.

The use of plain wrought iron or steel is becoming rare, while nearly one-half of the places sending in reports now use galvanized wrought iron or steel exclusively; in 56 per cent. of the places galvanized iron is used, either exclusively or in part. In 95 places lead or lead-lined pipes are used, and cement-lined pipes in 48 places. It is noticeable that the use of cement-lined pipe is largely confined to Massachusetts and New Hampshire, 46 of the 48 places using it being in these two states.

Of the new waterworks systems—those constructed within the past ten years—the following materials have been used for services: Galvanized, 24; plain wrought iron, 1; lead, 2; cement lined, 9.

The disfavor with which plain iron and steel are regarded is shown by the fact that 22 places have changed from these materials to some other, while only one place has reported as having taken up this material. Galvanized pipe, on the other hand, has lost only 17, while gaining 46. Lead and lead-lined pipes have gained 18 and 16 places respectively and lost 6 and 8. Changes to cement-lined pipes have occurred in 11 places, and changes from cement-lined pipes to some other material have occurred in 27 places.

A comparison of the number of places now using the different materials with the number of places where this material has been abandoned shows that 63 per cent. of those formerly using plain iron or steel pipes have changed to some other material. Eight per cent. have changed from galvanized iron; 19 per cent. from lead or lead lined, and 42 per cent. from cement lined.

Of those places where changes have been made from galvanized pipe to some other material, 13 are supplied from surface sources, 1 with ground water, and 3 with filtered water. Of the places changing from lead or lead-lined pipe to some other material, 5 are supplied from surface sources, 13 from ground-water sources, and 4 from filtered sources. Of the places abandoning cement-lined pipes for other material, 18 are supplied with surface water, 7 with ground water, and 1 with filtered water.

Reasons for Changes.

The reasons reported for the changes are varied. The changes from plain and galvanized pipes are almost entirely on account of rust. The changes from lead pipes are largely on account of the possibility of lead poisoning, although in some cases it has been on account of expense or because of the bursting of the pipes under pressure. Lead-lined pipe has been abandoned on account of lead poisoning and trouble from bursting and because of the difficulty in making joints which will not corrode. Of 20 places reporting the abandonment of cement-lined pipes, 8 were on account of trouble at the joints, 6 for convenience, 2 on account of expense, 1 on account of the difficulty in getting good work, 1 because of rust, 1 because the cement broke off, 1 because of outside rust.

A large proportion of the places where the works have been in operation for a sufficient time report trouble with service pipes, no matter what the material used, except in the case of cement-lined pipes. With cement-lined pipes, 54 per cent. of the places replying report little or no trouble. With galvanized pipe, 36 per cent. of the places report little or no trouble, and with lead pipe 10 per cent. so report. The trouble with iron and steel pipes, both plain and galvanized, appears to be through the entire length of the pipe. The trouble with lead pipes appears largely at the corporation cock. The trouble with cement-lined pipes is very largely corrosion of the outside of the pipe just inside the cellar walls, with some trouble at the lead gooseneck.

The data in regard to length of life of a service pipe and the period that elapses before it begins to give trouble are very unsatisfactory. The averages of the figures given in the returns are as follows:

	Years before trouble begins	Life of pipe years.
Plain iron or steel	12	16
Galvanized	15	20
Lead	10	25
Lead lined	10	23
Cement lined	14	28

Sources of Trouble.

The main sources of trouble from corrosion are largely inside the pipes, due to the action of the water. In certain soils, however, there is a rapid corrosion of the pipes on the outside, and, in case the inside is protected, as in the case of cement-lined pipes, this is the main source of trouble. Pipes laid in salt marsh or in cinder fill are certain to be acted upon rapidly. Pipes in clay are much more subject to corrosion on the outside than those in sand or gravel. One of the common places where trouble occurs it at the corporation cock, or where a gooseneck is used at the junction of the gooseneck with the service pipe. Some of the troubles at the corporation cock are due to the tuberculation of the main pipe, which tends to cover the corporation cock. This can be overcome in a large measure by inserting the corporation cock well beyond the inside of the main.

Wrought Iron and Steel Pipes.

The committee believes that there are very few cases where the use of either wrought iron or steel pipes without some protective coating for services is justifiable. They are certain to become filled with rust, and the expense of cleaning or renewing them will much more than offset the extra first cost of construction. Covering the metal with some protective paint seems to increase its life but slightly.

In the compilation of the returns wrought iron and steel have been grouped together, as it is evident that the words are used interchangeably in many cases. Of those making returns, however, very few have said that steel pipes were used, and a considerable number have called attention to the fact that only genuine wrought iron was used. Others have stated their belief in the superiority of wrought iron over steel, deeming it of sufficient importance to call for special remark.

The relative merit of steel and wrought iron has been a matter of controversy ever since steel pipe has been on the market. The steel pipe has the advantage of greater strength and lower cost, but the advocates of wrought iron claim that the steel corrodes more rapidly, has a much shorter life, and is more difficult to work. The advocates of steel contend that the life of steel is as long as, if not longer than, that of wrought iron. Both sides produce evidence to support their claims, much of which appears to be trustworthy. The claims of both sides, also, are supported by competent experts.

Behavior of Pipe Depends on Conditions.

The behavior of pipes under different conditions is so different that the greatest care must be exercised in drawing conclusions. The action of the different waters on both steel and wrought iron is quite different, so that the results obtained in different places cannot be compared. The action of the water on the pipes depends to a considerable extent on the quantity passing through it, and a pipe which contains dead water much of the time will corrode much less rapidly than one which has a continuous flow. For these reasons conclusions based on the appearance of occasional samples are worthless. The character of the metal should also be taken into consideration, as there is wrought iron pipe, for example, which is of inferior quality, and will not resist corrosion as well as genuine wrought iron, and there is undoubtedly much steel pipe sold as wrought iron.

The experience of waterworks superintendents, as indicated by the returns and as shown by previous discussions in the meetings of the association, is decidedly unfavorable to steel pipe, and while, undoubtedly, many of those who argue in favor of wrought iron pipes may be unfamiliar with anything else, and believe in it, there is certainly a large number of reliable men who have had an extended experience with both materials who are firmly convinced that wrought iron is much superior to steel, and there must be some good reason for this belief.

In regard to the working of the steel, there seems to be no doubt that the same tools used for wrought-iron pipes cannot be satisfactorily used for steel pipes, but that with suitable tools the steel pipes can be worked without any difficulty.

The feeling against steel pipes appears to be chiefly confined to New England, for it is undoubtedly a fact that a majority of pipes used in other sections of the country are of steel, and it is apparent that no more trouble is experienced from the use of steel in these places than is experienced from the use of wrought iron in this vicinity.

Galvanized Pipes.

The action of water on zinc is comparatively slight, and if the pipe—whether of steel or wrought iron—is completely covered with zinc the life of the service will be very materially lengthened. The chief trouble with galvanized pipe is in the joints, where the water gets directly at the iron, and in the imperfect covering of the iron.

As pipes are manufactured, there is a large quantity of scale left on the pipe, especially on the inside. In the galvanizing process this scale is simply covered with zinc. When the scale becomes loose, as it invariably will, the metal of the pipes is exposed in spots directly to the action of the water and corrosion begins, which tends to loosen still further the scale, and soon the pipe is little better than an uncoated pipe. The wrought iron pipe advocates claim that the greater roughness of the wrought iron insures a greater quantity of zinc, but the extra zinc in this case is obviously not so distributed as to be of any material value.

If the pipe could be freed from scale before galvanizing, leaving a comparatively smooth surface, the effects of galvanizing would be much greater, as there would be little opportunity for the direct action of the water on the iron. One of the steel compnies has now perfected a method of removing scale from the pipes, which would seem to be of enormous advantage, both in decreasing the friction in the pipe and in making it possible to obtain a much more durable coating of zinc when galvanized. This process, which is applicable both to wrought iron and steel pipes, is likely to result in the production of very much better galvanized pipe.

Galvanized pipe appears to be the cheapest practicable material for services where the class of street surfacing is not such as to make the renewal of the services a matter of great expense. They will give trouble, especially with waters which attack metals readily, but there is no possibility of danger to health in their use.

Whether steel pipe is as durable when galvanized as is wrought iron is a matter which is open to discussion. If the galvanizing is perfect, it would make little difference whether the metal under the zinc resisted corrosion more or less. With the process for removing scale above referred to, it would seem that a long step had been made toward getting a perfect galvanized pipe.

Lead Pipes

Lead is in many respects the most satisfactory material to use for service pipes. Its pliability and its comparative freedom from corrosive action make it almost ideal from a mechanical standpoint. The cost

of lead pipe of sufficient thickness to safely withstand the pressure is more than the cost of many other materials used for services, but in a paved street the greater duration of life probably more than compensates for the extra cost, and in places where the streets are occupied by other pipes and conduits the ease of getting over and under these obstructions with a flexible pipe is a great advantage. The most serious objection to the use of lead pipe for services is the possibility that the water may dissolve enough lead from the pipe to cause lead poisoning. It is certain that many cases of lead poisoning have been caused by the use of lead services. On the other hand, lead has always been used for services in most of the large places, without any unfavorable effects.

The reason why trouble has resulted in some places and not in others is found in the different character of water supplied in these places. With soft water which contains considerable carbonic acid, the action of water on the lead is very rapid. Waters obtained from reservoirs are not likely to have carbonic acid, and, instead of a corrosive action, the water tends to form a coating of an insoluble lead compound on the inside of a pipe. With such waters there is no great danger in the use of lead. The danger in such cases lies in the possibility that at some future time the character of the water will change, either by the introduction of new sources of supply or by filtration of the old supply.

It seems to be practically impossible to determine definitely in advance what the effect of any water on lead pipe will be, as the laboratory results fail in many cases to show the action which will occur in actual practice. Tests of service pipes in use for a considerable period are the only safe guides.

Lead-lined Pipes.

Lead-lined pipe as manufactured several years ago gave much trouble from the separation of the lead lining from the iron, leaving the metal exposed to the water. The pipe as manufactured to-day, however, appears to be durable, and prevents the corrosion of the iron or steel very effectively. It would seem that the life of such pipe would be limited only by the corrosion of the outside of the pipe. The expense of the lead-lined pipe is much less than that of lead pipe. All of the dangers from the dissolving of lead which have been enumerated in the case of lead pipes apply equally to lead-lined pipes. The health authorities of several of the New England states advise most strongly against the use of lead for service pipes, even where the character of the water now in use is such as to indicate that there would probably be no injurious effects.

Cement-lined Pipes.

Cement-lined pipes, if properly constructed, make ideal service pipes as far as the interior of the pipe is concerned. The cement is not acted upon by water, and the interior of the pipe will remain smooth for an indefinite time. There are many places where cement-lined pipes have been in use for many years without any trouble, and there are many others where they have given so much trouble that their use has been discontinued. The reason for the troubles which have been experienced are found to be generally the improper lining of the pipes or the use of fittings which did not prevent the water from getting to the metal.

Much information has been secured in regard to the methods of making cement-lined pipes and of joining them so as to prevent corrosion at the joints. This information will be given in the final report of the committee, but need not be given in detail here.

Trouble with cement-lined services occurs most frequently from corrosion on the outside of the pipe, and especially where the pipe enters the cellar. In many cases the action on the outside of the pipe is quite rapid, and samples have been submitted to the committee where the iron has been completely eaten through and nothing but the cement remains to hold the water. This rapid corrosion is undoubtedly due to the dampness inside the cellar wall. Various methods have been suggested for remedying this. A short piece of the pipe where it passes through the cellar wall may be incased in cement. Another suggestion is that a coupling be placed just outside the wall, so that the corroded piece may be readily removed and replaced.

The use of galvanized pipes for lining with cement undoubtedly gives the pipe a much longer life, as the outside is in this way protected from corrosion to a large extent. Painting the outside of the pipe is resorted to in some places, with good results.

Size of Service Pipes.

The standard size for services is ordinarily ¾ in., but in several cases this size has been increased to 1 in. or even to 1¼ in. for the purpose, chiefly, of lengthening the life of the service. Where plain or galvanized steel or wrought iron pipes are used, the pipes soon fill up with rust, but the service which they render is fairly satisfactory until the pipes become nearly choked, when they must be cleaned. A 1-in. pipe has about twice the area of ¾ in. pipe and will probably last at least twice as long before it will require cleaning. Where meters are not used, there is some objection to the use of large service pipes, as the waste of water from leaks and from carelessness, and especially the use of water through garden hose, is considerably larger with the larger service. Where meters are used, this objection does not apply, and it seems to the committee that much trouble and expense might be saved, where pipes are used which are liable to corrode, if the services should be made of larger size.

Rigid Connections and Goosenecks.

Rigid connections with the main and the omission of the goosenecks are used in a large number of places, and in some places such connections are used exclusively. Rigid connections make a considerable saving in the first cost, and are much more readily cleaned. On the other hand, the gooseneck permits the dropping of the service below the main and away from frost, and it is possible to make the service take any direction from the main.

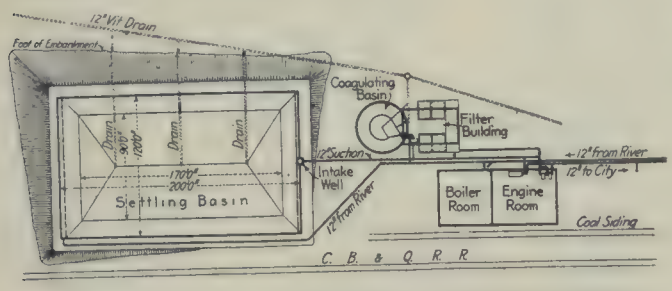
Where rigid connections are used it is necessary to have good soil in which the pipes will not settle, and it is necessary to have the pipes rest on a firm foundation, as any settlement in the service pipe near the main will cause the service to break. The digging up of the street near the main may also cause trouble to rigid connections. The fact that 83 of the towns reporting use rigid connections to a greater or less extent, and that 56 of these report no trouble and many others "little trouble" or "some trouble," would indicate that the use of rigid connections is thoroughly practicable.

During the past few years great advances have been made in the methods of cleaning service pipes, and it is now possible to save large sums which have heretofore been paid for digging up the services and for renewals. The committee has not discussed the merits of the different types of cleaners, but all of them seem to have some merit. The most satisfactory in many cases, and especially with lead pipes or when goosenecks are used, is the force pump and wad of paper which permits the cleaning of the gooseneck and corporation cock as well as the straight pipe.

Special Devices in a Small Town Mechanical Filtration Plant

MECHANICAL filtration plants are coming more and more into vogue, and there is quite a tendency for small cities or towns to instal purification systems of this nature. Of this account the following description applying to an installation in a small Missouri city is of interest. This plant involves several special devices intended to improve the operation of the filters. The account which follows is by E. E. Harper, in Engineering Record:

A circular coagulating basin, automatic proportional chemical feed devices, an unobstructed pipe gallery, draft tubes for washwater, supplemental coagulation at each filter unit and rate controllers which regulate the flow automatically in accordance with the demand for water in the city—these are a few of the features at the mechanical filtration plant which has recently been completed for the city of Chillicothe, Mo., which has a population of 10,000, and obtains its supply from the Grand River. The river water is pumped by De Laval centrifugal units a distance of



General layout of a water purification system for a small town involving a settling basin, a circular coagulating basin and a filter plant of the mechanical type.

two miles to a 1,800,000-gallon rectangular concrete-lined settling basin, 120 x 200 ft. in plan. Thence it passes through the coagulating basin to the filter.

The coagulating basin, of reinforced concrete, is circular, 42 ft. inside diameter, 11 ft. deep, and has side walls 12 in. thick. So far as the writer is aware, this is the first circular coagulating basin built in this part of the country. The baffle walls are also circular, and the whole construction is such that all sharp turns and dead spaces are eliminated, as the raw water, after being treated with the proper dose of coagulant, enters at the centre of the basin and flows in an ever-widening circle until it is ready for the filters. A basin of this type costs only about two-thirds as much as a rectangular basin of the same capacity, and is, the writer believes, more efficient.

The mixing chamber is a rectangular space in a small compartment in that part of the basin which extends underneath, and is enclosed by, the filter house. Here the raw water is discharged through an orifice plate of such size that 700 gallons per minute produces a jet about 9 inches high, and the chemicals are discharged in a stream at this point and thoroughly mixed with the stream as it falls from the orifice. The treated water then passes a series of wooden baffles and flows through the pipe leading to the centre of the basin.

Chemical Treatment.

Coagulants, lime, and alum are mixed in circular concrete tanks and discharged through chemical feed devices which automatically proportion the flow of coagulants to the amount of raw water pumped to the coagulating basin. Each device consists essentially of a small tank, called the tilting tank, cylindrical in form, about 10 in. in diameter and 15 in. long, open on one side, with closed ends, and fitted to rotate 30 degrees about its major axis and approximate centre of gravity. Attached to one side of this tank is a spout or piece of pipe about 18 in. long, the end of which is fitted with an adjustable orifice. This tank is kept filled to a uniform height with the chemical solution, regulated by a float valve, as in the usual type of orifice box.

The tilting tank is actuated by means of a cable fastened to the end of the spout thereon, running over suitable pulleys, and attached to a large float, which, in turn, is moved up or down by changes in the water level of a small tank that is connected, by means of piping, to the pipe through which raw water is discharged into the coagulating basin. In operation the coagulant is therefore discharged from the tilting tank, through the orifice on the end of the attached spout, under the same head as the raw water is discharged through its orifice into the coagulating basin. The chemical feed is always in exact proportion to the amount of raw water entering the coagulating basin, and the quantity of water entering the coagulating basin is regulated by the demands of the filters, and is controlled by a float-operated butterfly valve in the coagulating basin.

The pipe gallery is 12 ft. wide, 8 ft. high in the clear, with the floor on the same level as the bottom of the filters, and the piping is so arranged that there are no pipes overhead or on the bottom of the gallery, where they would interfere with walking. There is a clear space in the centre of the pipe gallery 6 ft. wide.

Unobstructed Pipe Gallery.

The pipe gallery really contains the most important parts of the filter plant, but as a rule pipe galleries are so arranged that they are hard to get at, poorly lighted, and ventilated, and are generally avoided as much as possible when the superintendent is showing visitors around the plant. The writer has always insisted that more attention should be paid to this part of a filter plant, and feels well repaid for the efforts that were made in this case to secure a pipe gallery that would be just as accessible as any other part of the plant, and which would not invite neglect on the part of the operators at the plant.

Space is provided for six filter units, each 11 x 14 ft., but only three units have been equipped. As constructed, the weir wall and small compartment usually built in one end of each unit on filters of this size to receive the washwater discharged from the wash troughs were omitted, and the wash troughs were carried the full length of the filter unit. They discharge through special castings set in the front wall of each filter unit and connect to the sewer. This is the first instance in which the writer has used the principle of the draft tube to facilitate the discharge of wash water from the troughs in a filter, but it worked well and has since been used on other plants with equal success.

This form of construction, by which the small compartment at the end of the filter unit was omitted, allowed the capacity of each filter unit to be increased 15 per cent. over the usual form of construction with-

out increasing the space required for the filter unit, and the cost of the few extra laterals, strainers, and extra sand was insignificant.

Supplemental Coagulation.

To insure a high bacterial efficiency of the filters soon after washing, the writer worked out a plan which is very simple, and which he believes will be widely used when the importance of this matter becomes more generally known. No rapid sand filter will give good bacterial efficiency until sufficient coagulant has been deposited on the sand bed to form a good mat, and if the water as it comes to the filter carries sufficient floc to make a good coating in less than an hour, the period between washings of the filter will be too frequent. Very few operators filter to waste for more than five minutes, and, as a result, most filters are operated in such a manner that the bacterial efficiency for the first hour or two after washing, or at least 10 per cent. of the time, is very low, and the much-talked-about "98 per cent. removal of bacteria," which is the basis of most filter-plant guarantees, is, after all, a delusion.

How many companies furnishing filter equipment would be willing to guarantee 98 per cent. removal of all harmful bacteria if the tests were to be made within one hour after the filter was washed, and at the same time guarantee such low percentages of wash-water as are now guaranteed

At the Chillicothe plant a small porcelain-lined tank, holding about five gallons, is placed on the operating floor beside the alum solution tank. It can be filled to a predetermined level by opening a valve on a pipe leading to the alum tank. Leading from this small tank are three lead pipes, with a valve on each pipe, and these pipes are connected into the raw-water inlet to each filter, so that after a filter is washed the raw water for that particular filter can be given an extra dose of coagulant. This is done while the filter is being filled again after being washed, and the raw water and coagulant are thoroughly mixed as they flow into the filter.

The filter is then allowed to stand for a few minutes, during which time the coagulant forms and settles on the sand bed, thus affording ideal conditions under which to begin filtering with high efficiency. The first water is filtered to waste in the usual manner, except that the water thus wasted does not go to the sewer, but flows back to the large settling basin, and is later filtered over again.

The clear-water well is underneath the filters, and has a depth of 10 ft. and a capacity of 100,000 gallons. From this well the water is pumped direct to the city by either of two motor-driven centrifugal pumps, located in the engine room in the electric light plant, and operating under a minimum suction lift of 15 ft.

Rate Controllers Regulate the Flow.

The discharge from each filter unit is controlled by a rate controller located in the pipe gallery, but with a handwheel connection extending to the operating floor, so that the rate of flow of each filter can, if desired, be regulated by the attendant from the operating floor.

Under all normal conditions the controllers are set for the normal capacity of each filter, and they automatically maintain this capacity until the filter requires washing, or until the clear-water well is nearly filled with water, when they gradually throttle the discharge of their respective filters, but never shut off the flow completely unless the pumps are shut down, in which event the throttling of each filter is so gradual that the flow is not completely stopped for perhaps an hour.

With these controllers it is impossible to flood the pipe gallery, yet the clear well is always kept well filled with water ready for emergency. In case of fire they can quickly be set to give twice the normal flow, and yet perform all their automatic features.

These controllers operate on the principle of maintaining a constant head of water through a variable orifice, the size of the orifice being regulated by a cone-shaped plug, actuated by a handwheel from the operating floor to change the rate of discharge through the orifice. They have proved to be especially well adapted to the conditions of Chillicothe, where the city uses the direct pressure system, and has several customers who use water in large quantities at irregular periods, for the clear well is always well filled, yet never overflows.

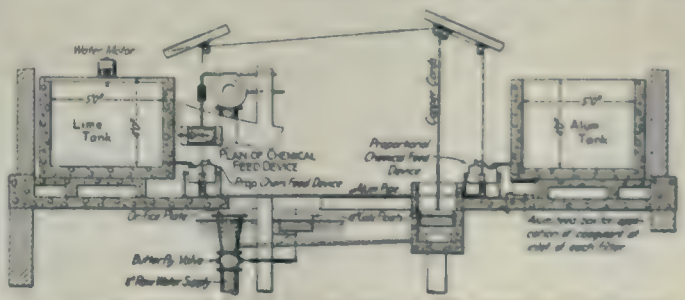
It is the custom in many plants, both large and small, to meet the varying demands for filtered water during the day by shutting down or starting up one or more filter units, and this practice results from the fact that very few filter plants are equipped with controlling devices which will automatically perform this function by varying the rate of all the filters instead of starting or stopping one or more units.

Continuous Operation Preferable.

Whenever a filter is shut down, even for a very brief interval, small bubbles of air or gas which tend to collect in the sand during filtration will rise to the surface, and in so doing they break the mat which has formed on the sand, and when the filter is started again the rate of filtration through these broken places is very rapid and the bacterial efficiency of the filter is very low.

The writer believes that if a filter is kept in continuous operation from the time it is started until it is washed that the results therefrom will be much better, even if the rate of filtration is very small at times. It does no harm to change the rate of filtration while the filter is in operation, provided that the change is made slowly.

Air and water are used for washing the filters, the air being supplied through a separate system of pipes, so that the flow of washwater can be started before the



Automatic chemical feed device, involving a tilting tank and galvanized floats for supplying coagulant in proportion to the flow of water.

air is turned off. A novel feature in connection with the air wash is that the air is carried to the different filters through a wrought-iron pipe, so arranged as to form a handrail around the filters.

All loss of head gauges, clear well gauges, etc., are of the vacuum type, with mercury columns. All valves are hand-operated, and all valve stands are on line, instead of being spotted all over the operating floor.

C. F. Cole & Co., Ltd., have succeeded to the business of Eugene Dietzgen & Co., drawing materials, Toronto.

The Ship Building Industry in Canada is Reviving

COLONEL THOMAS CANTLEY, president of the Nova Scotia Steel and Coal Company, recently delivered an address before the Canadian Manufacturers' Association at New Glasgow, N.S., dealing with the shipbuilding situation in Canada and particularly in the Maritime Provinces. He quoted figures showing the status of the industry in Canada during the past forty years; these indicate that while Canada was very active in wooden shipbuilding, since the advent of steel vessels there has been a severe decline in the tonnage produced in the country. For instance, 42 years ago, in 1874, the tonnage of the ships built in Canada totalled 190,758, as against a total of only 43,346 tons in the year 1914. Col. Cantley stated, however, that at the present time the Maritime Provinces give evidence of a revival of interest in the matter of shipbuilding, and made mention of the modern high-powered steel freighter of about 2,000 tons dead weight, which is now under construction at the Scotia plant. This vessel is to be driven with geared, high-pressure steam turbines, with a steam consumption not to exceed 11½ pounds per shaft horse power—a result about 25 per cent. better than given by engines of the best modern triple reciprocating type.

Emphasis was laid by Col. Cantley on the necessity for adequate government assistance to the industry, and he stated that the old system of granting bounties to shipping in Canada was obsolete and the amount available too trifling to be effective. In his opinion the bounty should be $10 per ton dead-weight, calculated on, say, Lloyd's freeboard, in the case of all sail or steam vessels, while in the case of steamers this should be supplemented by a further bounty of $2.50 per indicated horse power for propelling machinery, provided that such machinery is the product of Canadian workshops. This system, he stated, was practically the same as that used by the Japanese Government, and appeared to be the best adapted to our present needs. He quoted figures showing what other countries were doing in the matter of government aid to this industry. The United States, for example, in the fiscal year of 1914, paid in subsidies to steamers under contract the sum of $1,089,361, and the French Government paid out in one year more than $2,000,000. The bounty granted by France at the present time is about $19 per ton, and ten years ago, when the system of government aid was inaugurated, the amount granted was $28. The following table shows the growth of the merchant marine fleets of various nations, which, under the stimulus of assistance by the state, has been remarkable:

	1895, tons.	1915, tons.
Great Britain	13,242,630	21,045,045
United States	2,164,763	5,368,194
Austria	304,970	1,055,718
Denmark	356,714	820,181
Holland	448,861	1,495,455
France	1,094,752	2,319,438
Germany	1,886,812	5,459,296
Italy	778,941	1,668,296
Japan	301,101	1,708,386
Norway	1,659,012	2,504,722
Russia	487,681	1,053,818
Spain	554,238	898,823
Sweden	497,887	1,118,086
Canada—1894 to 1914	868,624	932,422

Col. Cantley stated that the industry could be developed in Canada, also, on a large scale, if the Government would grapple with the matter in a broad and statesmanlike way. Practically the only material requisite for the construction of steam tonnage in Canada not now produced by Canadian mills are the larger and heavier steel sheets for the hull plating and boilers, and if the mills were assured of the same protection on these sheets as on steel bars and other forms of finished steel, there was little doubt in his mind but that within a few months they would be in a position to supply all the plates necessary for a very substantial addition to our merchant marine. In concluding his remarks, he spoke of the great loss in merchant ships from August 1, 1914, to August 1, 1916, the number being 1,486, with an aggregate gross tonnage of 2,312,644, and said there was no doubt that there would be a tremendous demand for merchant tonnage not only while the war continues, but for a decade thereafter. He urged that immediate action was imperative if we in Canada were to participate in supplying this demand and building up a Canadian mercantile marine to carry in Canadian bottoms our own exports and imports.

How to Maintain Concrete Roads and Streets

CONCRETE roads, like all other types of pavements if they are to give their maximum service, must be properly maintained. The small amount of work and small expense necessary to maintain a well-built concrete road in perfect repair should not be made an excuse for delaying the work, but rather an incentive to have it done immediately. Maintenance should be systematic and imperfections given immediate attention.

Cracks.

Cracks in concrete roads occasion no inconvenience whatever to traffic, and traffic will not injure the road at such a place if the crack is filled with tar and covered with sand. The crack should first be cleaned with a stiff wire broom and all loose particles of material removed. If the crack is too narrow to permit cleaning in this manner, it may be cleaned with an air jet from an automobile pump. Tar should then be poured into the crack in sufficient quantity just to flush over the edges and afterwards covered with coarse dry sand.

Refined coal tar should be used, having a melting point (half-inch cube method in water) of about 100 degrees Fahrenheit. The tar should be heated from 225 to 250 degrees Fahrenheit at the time of application, and may be applied by means of a sprinkling can with spray nozzle removed. Sand or screenings, thoroughly dried, graded from ⅛ to ¼ inch, should be spread over the surface before the tar has cooled.

Small Holes and Depressions.

Where a small hole occurs, due to the displacement of a lump of clay or a piece of coal or wood, it should be thoroughly cleaned and filled with tar and stone chips. If the hole is two or three inches in size, it should first be wiped with the tar and stone chips put in; these are covered with more tar and sand and tamped into place.

If for any cause the surface of the concrete has scaled and a slight depression formed, it can be coated with tar, stone chips added, these in turn covered with tar, and the whole covered with sand and tamped into place.

Deep Holes.

If through neglect or other causes a hole of any considerable size and depth has formed in the surface of a concrete road, the concrete surrounding the edge

should be cut away until the walls are made practically vertical and cut to a depth of at least three inches, or as much deeper as the hole may be. The hole should then be filled with water and stand for a few hours, after which the water should be removed, the sides washed with cement paste, and the hole filled with concrete of about the same materials and mixture as that in the original road. The surface should be finished with a wood float and brought to a true shape with the surrounding surface of the concrete, then covered so as to protect it from traffic. This may be done by the use of steel plates or pieces of plank, which should in turn be covered with moist earth or gravel. This will permit traffic to use the repaired portion of the road without injuring the concrete. On a wide street where there is sufficient room a barrel could be placed over the hole and traffic diverted around it.

If it is necessary to cut a hole through the entire thickness of the concrete slab, gravel should be placed in the sub-base and thoroughly rammed, so as to form a compacted base on which the new concrete will rest. Where water has been allowed to stand in such a place, it should be compacted after the water has been removed and just before laying the concrete.

The consistency of the concrete should be sufficiently stiff to require considerable tamping to bring water to the surface so that it may be possible to ram it thoroughly into place.

A new patch should be kept moist for at least four or five days and protected from traffic at least ten days.

Novel Railway Station Canopies

THE accompanying illustrations show a novel canopy, designed for railway stations, the special features of which are the pre-cast concrete posts and slabs. Each column is of T-shape, supporting one end of each of four similar slab units. The columns are 16 in. by 12 in. in section, and 16 ft. high, including 3 ft. imbedded in the platform and footings. The cross beams are 11 ft. long. The canopy is composed of slabs, as shown in the illustration, each one of which forms a half-section and measures 9 ft. 9 in. wide by 20 ft. long and 3 in. thick. They are ribbed and sloped toward the middle. The total width of the canopy is 19 ft. 6 in.

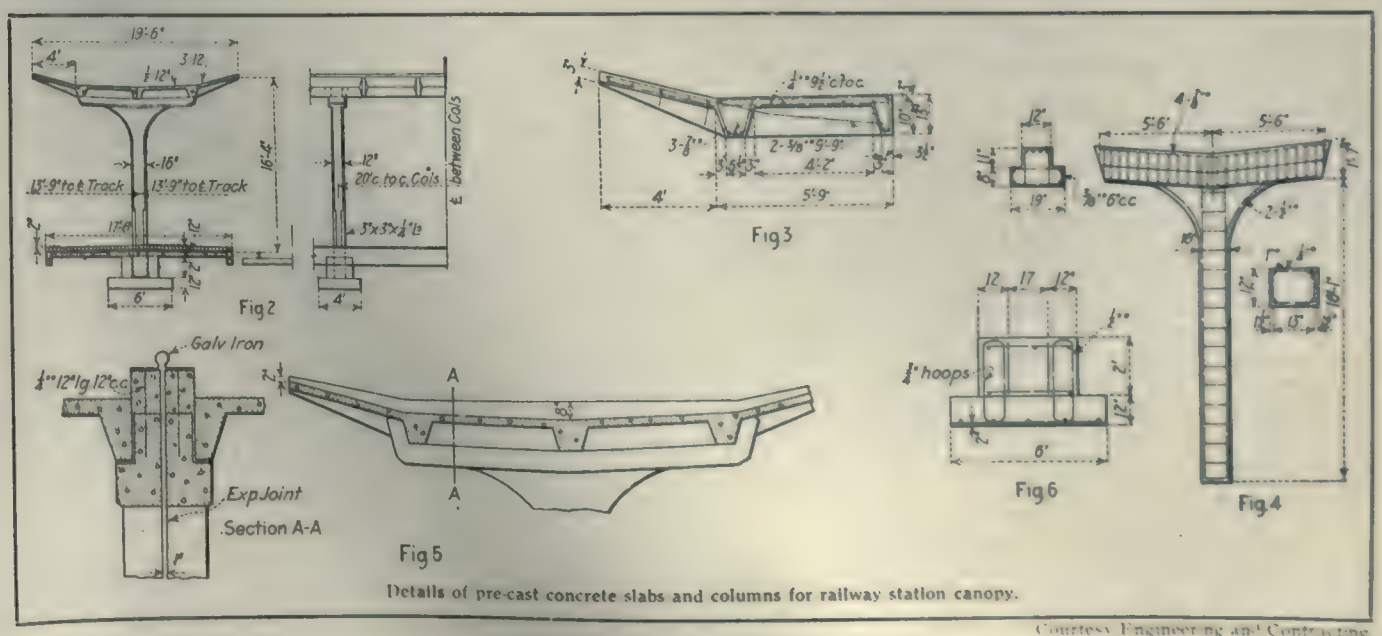
The units are made of concrete and pre-cast some distance from the station. Wood forms covered with galvanized iron are used, these being laid on steel rails carried on ties. Slabs are cast every other day and moved to the stacks for curing in six days. Columns are poured once a week and left for a period of three weeks. The units are sprinkled every day for ten days. When sufficiently set, the slabs are removed from the bottom forms by a travelling locomotive crane and stacked six deep with strips of wood between

Fig. 1.—Method of handling pre-cast units for station canopy.

them to prevent centre-binding. After seasoning they are loaded on flat cars and set in place in the canopies.

The mixture used is in the proportion 1:6 mixed in a mixer feeding into a half-yard bottom-dump bucket, which is picked up by the crane travelling along the yard and delivered as required.

The reinforcement for the column beams is built up outside, while that for the slabs is laid in place. Hooks are inserted to allow the unit to be picked up with the crane. The one crane travels up and down the yard, placing the concrete, transferring the units from the forms to the curing stacks, loading them on the flat cars, and erecting them in place.



Details of pre-cast concrete slabs and columns for railway station canopy.

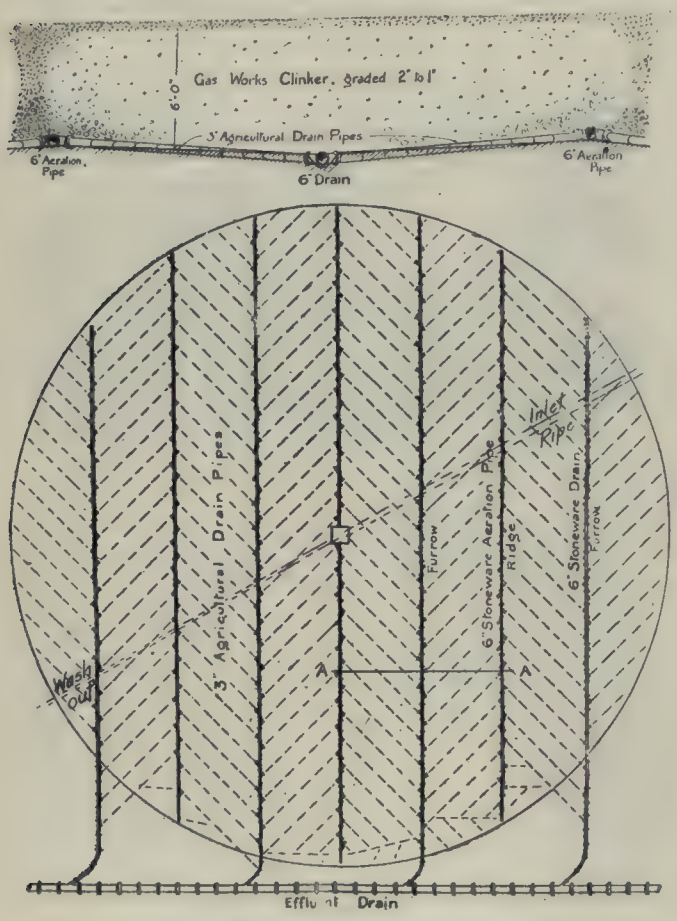
Courtesy Engineering and Contracting

Economical Sewage Filter-Bed Construction

The percolating filter-bed is now a very usual feature in a sewage disposal scheme, and where adopted is sure to be responsible for a notable proportion of the cost of the scheme. It is not at all a costly item per unit of area, but as it is only by the use of ample filter area that a satisfactory effluent can be obtained, the aggregate cost is considerable.

Any method, therefore, of reducing the cost of the construction of such beds is worthy of close consideration, for a small saving on each square yard will mean an appreciable reduction of the total cost.

Yet it would be very false economy to reduce the cost of the filter if by so doing the efficiency of the



An inexpensive but effective sewage filter bed.

bed is impaired or its effective life shortened. If the effluent obtained is not satisfactory it is no consolation that the beds were cheap; while to have to rewash the filtering medium at the end of every five, or even ten, years, is to be saddled with a heavy maintenance cost, as well as to be in constant risk from an effluent of varying quality. Cheapness is not economy if it reduces efficiency or shortens life.

The chief item of cost, of course, is the filtering medium, and here local conditions are the predominating factor. What is cheap at one place is expensive at another, and each locality must make its own selection by the light of local knowledge, assisted by reliable information as to the relative merits of the types of material available for the purpose in view.

The next item in the scale of cost is what may be called the constructional works—viz., the concrete floor, the false-tile floor, and the walling. In some instances these works are pushed to considerable elaboration, and represent a heavy proportion of the total cost of the filter-bed. It is here, if anywhere, that a saving is to be effected, and the only sure guide of what may or may not be reduced or omitted is experience.

The Luton Filter Beds

In this connection a recent report by the borough engineer of Luton upon the filter-beds installed there some years ago is of interest. These filter-beds were constructed, most of them, in 1910-11, as part of the scheme then carried out for dealing with the whole of the sewage of the borough, the remainder having been added since 1914 to meet the requirements of a rapidly growing population. The beds are all similar in construction. They are circular, 100 feet in diameter, with a depth of filtering material of 6 feet, except in three cases, where the depth is only 4 feet. There is no concrete floor to the beds, the filtering medium being placed immediately upon the consolidated earth. The subsoil is chalk, and this was thoroughly rolled with a steam roller before the construction was commenced. The area of the bed was then shaped into a series of parallel ridges and furrows, the ridges being 25 feet apart, and having an elevation of 6 inches above the furrows, both furrows and ridges having an inclination of 1 in 200 towards the effluent drain, which passes the bed at right angles to them. A shallow grip is then cut up each furrow, and a 6-inch stoneware drain is laid along it, bedded in large clinker. Every pipe of this drain is a junction pipe, and the junctions are alternately right and left hand. From each junction a 3-inch agricultural drain pipe, also laid in a grip and packed in clinker, runs up the slope in a straight line from the junction to a 6-inch stoneware drain on the ridge, which is similar in all respects to the one in the furrow, except that its junctions point in a reverse direction and that it is not sunk in a grip. None of the pipes are jointed. The floor of the bed is thus provided with a system of subsoil drains. The drains from the furrows discharge into the main effluent drain, and those from the ridges are turned up at each end and open through the wall of the filter-bed to the air.

Upon the floor thus prepared the filtering material —in this case it consisted of London gas works clinker —is laid, grading and placing in position being done simultaneously. The wall of the bed is formed simply of large pieces of the material laid as rough walling.

Inexpensive Construction

From these particulars it will be seen that a cheaper form of construction than that adopted could not well be devised. The report referred to above appears to answer the question whether this construction is justified by results. It states:—

"No. 1 filter-bed was opened and examined in the summer of 1913 after a life of three years, and a report upon its condition was then presented. This year (1916), after being continuously at work for six years, the bed has again been opened up and carefully inspected. The drains were found to be perfectly clear and free from any trace of solid deposit. The filtering material in the top half of the bed was quite clear and contained no deposit at all. Below this there was a small quantity of deposit to be found on almost every piece of clinker, but there was no indication of the deposit being anywhere in such quantity as to approach a condition of local silting up. Compared with the condition found on examination three years ago,

there can be no question that at present the bed is cleaner than it was then. This would indicate that the deposit present is one which is continuously being washed away and continually added to in the working of the filter, and is the normal and natural state of the bed, and in no way indicative of deterioration. It is worthy of note that the particular bed examined has been in continuous use during the past twelve months, without even the briefest period of rest, but has worked night and day, seven days a week, at full capacity. . . .

"As you are aware, the quality of the effluent obtained has always been of the highest, and has satisfied the Lee Conservancy.

"The conclusion arrived at is that the bed is quite self-cleansing, and will continue to give efficient service for an indefinite period."

There are twenty of these filter beds in use at Luton, and it will be evident that the saving secured by omitting the usual brick walling, false and concrete floors must have been very considerable, and, apparently, so far as results go up to date (and six years is a fair period for discovering defects), the filters are as satisfactory as any filters, however constructed, could be.

We are indebted to the London Surveyor for this article.

The Heating and Ventilation of Munition Factories

The efficient heating and ventilation of all factories is absolutely necessary if the maximum output is to be obtained, as the health of the workers must be maintained, and the initial outlay, together with the annual cost of running the apparatus, will be more than repaid to the employer who studies the comfort of his employees by providing healthy workshops. Even in the most successful types of factory buildings the large numbers of workers employed in one apartment, together with the heat generated by motive-power and plant, and the smell given off by the materials, render some system of induced ventilation necessary, especially in cold weather, when the natural ventilation is often partially or totally suspended by the closing of windows and skylights.

War Conditions.

At the present time the conditions of war have the effect of rendering the subject of even greater importance than in normal times, for the following reasons: (1) The work is carried on in factories at a greater pitch and working hours are longer; (2) a great deal of female labor is employed, and this calls for better conditions; (3) the shortage of labor generally makes it essential to avoid sickness wherever possible, as workers cannot easily be replaced; (4) many of the buildings used for munition work were not designed for the purpose and are therefore far from ideal.

In face of all these reasons for dealing with the subject, there is the need to economize in every possible direction, both in material and labor, and, in addition, the designer will experience difficulty and delay in getting even those essential parts of his apparatus which require any sort of skilled labor in execution, as the energies of the industrial world are entirely devoted to the production of actual machines of war, and the equipment of any building is compelled to take second place.

A building can be used without the heating and ventilating systems being completed, and this is often the case at the present time, which fact renders it necessary to keep every system as simple as possible consistent with efficiency, in order that the scheme may be completed speedily and the maximum benefit accrue from its installation before the health of the workers is affected. More especially in buildings of a temporary character is this essential, because the life of the structure is likely to be a short one, and once the war is over demolition will follow, with the consequent "scrapping" of any installation within the building.

One of the most striking features of building work during the past two years has been that the class of structure erected in nearly every instance is such that new problems have been presented to the designer. It is quite true that in ordinary times of peace no two buildings present exactly the same features, but in the case of munition factories an entirely new field of design has been entered upon, and preconceived notions have had to be considerably modified to meet the exceptional circumstances. Architects and engineers have, however, risen to the occasion, and the new problems have been tackled in a spirit which reflects credit upon them.

It is quite obvious that the majority of designers had practically no experience of explosive factories, as the work in the past was very limited and confined to a few specialists; while there is no published matter that is available to those outside government departments. The vast amount of work to be done, however, necessitated the employment of many persons who were not specialists in the subject, and thus considerable ability was required in producing satisfactory schemes at short notice. Again, there are cases of quite new types of buildings which have to be erected for new processes and wonderful explosives which have been invented since the war began, and for which absolutely no data existed.

In the last mentioned in particular the heating and ventilation schemes have presented unique problems, and it would be extremely interesting if some actual details of specific cases could be given, but this, of course, is impossible.

Heating.

The heating of munition factories is a matter which requires considerable care, owing to the absolute necessity for avoiding any possibility of sparks which would cause fires and explosions. At the same time efficient heating is absolutely necessary in many cases, as a uniform temperature must be maintained in order that various processes may be successful, and, as this temperature is often one which is excessive as regards the comfort of the workers, efficient ventilation must be provided in conjunction with the heating. Ordinary coal fires can be considered at once as being practically impossible in nearly all cases, and, although gas fires can be adopted in some instances, these cannot be looked upon as a method of heating large apartments in such buildings, even when there is no risk of explosion in the immediate vicinity and a gas supply is available. Hot-air heating is not generally employed in munition factories. The alternative methods are electric radiators, hot water heating, steam, and various gas appliances. Of these, electric radiators, although perfect as regards cleanliness and convenience, are

often expensive when required in large numbers, even if the current is generated in a power station which forms a part of the factory buildings, and for this reason they are not extensively employed. A supply of steam is practically always available in a large factory, as it is required for many purposes, and with a complete installation of mains about the building it offers a simple solution of the heating problem. Steam pipes can be carried round skylights and radiators provided under the windows, and with a properly-designed system the heating can be regulated to a nicety.

In some types of factories the work is divided up into distinct operations, which have to be carried out in distinct and separate buildings, and these buildings are often so scattered that it renders it very difficult to deal with the heating under one scheme, while any attempt to deal with each one separately becomes an expensive matter, as it necessitates the duplication of the primary source of heating. With the use of steam as the heating medium it is possible to carry the mains for some distance, but it frequently happens in establishments of this kind that what may be described as a composite system is used, i.e., steam is used for the main buildings and hot water, gas, electric radiators, and even coal fires are used in smaller separate buildings, according to the suitability of the system and the sources which are actually available in each particular position. A great deal depends on the nature of the power which is being used in the factory, the arrangement or grouping of the buildings, and the class of work which is being produced, and it is quite impossible to state any fixed rule as to the system that should be adopted in the numerous munition factories which are now in being or in course of construction.

Heating Is Difficult in Temporary Buildings.

In temporary buildings the heating is usually a difficult matter, as the outlay required for a complete and efficient installation is often prohibitive, and the nature of the construction of the outer walls and roof is such that there is a great loss of heat and more units are necessary to produce a constant uniform temperature. There is also a difficulty in maintaining a healthy temperature, and the feeling in either one of insufficient warmth or excessive heat according to the general arrangement of the building and the outside weather conditions.

In newly-erected buildings of the more permanent character it is an excellent method to use hot wall panels, which are constructed with small pipes embedded in the plaster, as these give a pleasant, efficient warmth and have the advantage of helping to dry the building quickly—a distinct consideration in these days of early occupation after completion. This system will not, of course, be applicable to numerous buildings of the factory type, as the walls are left unplastered; but in such cases the pipes can be laid in the floor material, and this method assists in keeping the feet warm during the winter. It is an absolute necessity to provide some system of heating in every factory building, and the essential factors are that the outlay should not be excessive; it should be simple and easily regulated, and it should be such as will produce a pleasant heat. When installed in new buildings it should be completed as soon as any of the services, in order that the apparatus may be put in operation and the heat used in assisting to dry out the moisture that is inevitable in all new structures.

Ventilation.

As previously stated, the ventilation of all munition factories must of necessity be dealt with in conjunction with the heating, and the two are inseparable if the building is to be successful. The ventilation system must be one which can be controlled and regulated to perfection, because it will not be efficient if this is not the case. With munition factories the varying conditions, which offer such difficulties when dealing with heating systems, apply equally forcibly to the question of ventilation. Natural ventilation has been partly resorted to in many cases, and when provided with some kind of controlling arrangement it has proved satisfactory; but this generally applies to small apartments and in instances where no poisonous or dangerous fumes are given off. Extract ventilators for drawing air through the roof and similar devices have probably been in greater demand during the past two years than for many years previous, and the several excellent types which are on the market have given great satisfaction. The respective merits of forcing in the fresh air and allowing the vitiated air to escape through outlets owing to the increased pressure, or of drawing out the vitiated air with fans and allowing the fresh air to be sucked in at certain arranged inlets, have been discussed many times, and each system has its adherents; but in the case of munition factories it has frequently happened that the designer has had to face conditions which do not permit of any choice, and he has been forced to adopt whichever of the two systems is practicable.

In explosive factories there are frequently rooms which either have to be heated to an excessive temperature on account of the process being carried on or the mere fact of the process being in operation causes an excessive heat to be generated, and it is with these rooms that the ventilation scheme has chiefly to deal. Where no unpleasant fumes are generated it is possible to give a supply of fresh air to the rooms and draw the warm air through other apartments, and thus take advantage of what would otherwise be waste heat. When one portion of the building is considerably higher than the remainder this can sometimes be used as a natural upcast for the warm air, and a very simple and cheap scheme will result. In those rooms where dangerous fumes are generated the ventilation becomes a more difficult matter, as it often happens that these fumes will attack and quickly destroy any extract fans that are installed, and the only method to adopt in such instances is that of neutralizing the fumes before the fans are reached.

Neutralizing Fumes from Explosive Factories.

This neutralization will be accomplished by drawing the air through specially-constructed pipes and chambers wherein an agent is employed to suit the particular gas or fumes which are to be treated. It must also be remembered that it is not permissible to discharge large volumes of vitiated air which may contain a large percentage of fumes or gas of an explosive nature, as the contact of sparks from a neighboring furnace or fire would cause serious results.

In the laboratories the ventilation will obviously be a very important matter, and, in addition to the extraction of the vitiated air in the main rooms, it will be necessary to provide specially-constructed draught cupboards with suitable outlets, in order that operations which produce obnoxious fumes may not affect the general work.

The effect of scattered buildings is not so difficult to overcome in the design and installation of the ventilation scheme as it is in the case of the heating system, because if mechanical ventilation is necessary the question of running small cables for electric power to drive fans is a simple one, and it frequently happens

with scattered buildings that no mechanical system is required.

There are many other points to consider in dealing with the scientific ventilation of factories, such as the portions where radiant heat is given off and the workers are engaged under very trying conditions. An excess of fresh cold air is disadvantageous in rooms of this kind, as it will be found that, if there is a continual supply of air which prevents the worker from perspiring, then the radiant heat will become even more intolerable. Exactly the same conditions will not be found in any two factories, and thus it is impossible to lay down any definite rules until the particular circumstances are known. In some buildings a certain scheme of ventilation is necessary to assist in the actual carrying out of the process, while in other structures the process is such that only the minimum ventilation which will enable the workers to continue is permissible. It therefore remains for the engineer to study the subject from the two aspects and endeavor to satisfy both conditions with sufficient margin for variation in order that any necessary adjustments can be made when the actual working conditions are in existence.—The Builder.

Construction Camps for the Winnipeg Aqueduct

The October issue of "Contracting" contains the following short article on portable houses used on the construction of the Winnipeg aqueduct for the water supply of the city of Winnipeg, Canada. This is through a practically uninhabited country, largely of a swampy nature, and made necessary the provision of particularly well designed construction camps. The work covered by the contracts which this company has, reaches over 60 miles, and camps have to be moved frequently. The company, therefore, devised a system of portable houses, which could be taken down, moved on flat cars, and erected quickly and without injury to the structures. These camps are for summer use only, as the weather is too cold to permit construction during the winter, and consequently they have only single walls.

Character and Equipment of Buildings.

The buildings are made up of panels of a maximum height of about 10 ft., some of which have windows and doors framed therein. The roofs are also made in sections, and the buildings are assembled by bolting through the studding pieces of adjoining panels which act as flanges. The floors are also made in panels. This permits the extension of any one building to any desired dimensions. The widths are about 14 ft., and the lengths vary, the maximum being for the dining-rooms and kitchen, which were as much as 60 ft. long.

In each camp the men are lodged in a bunk house with double-deck steel cots. The bunk house is used only for sleeping purposes, a separate house being provided for entertaining, where newspapers and periodicals are provided; other diversions are permitted. The dining-room and kitchen are in a separate building, and the office and residence of the superintendent of each contract are in another building. At each camp a separate wash house is provided, with stationary wash-tubs, in which the men can wash their clothes and bathe, as no bathing is permitted in the bunk house.

All the windows and doors of the camp are screened to exclude flies and mosquitoes. In some camps the windows are hung on hinges at the top and pushed out at the bottom. In others the windows are hinged at the bottom and pushed out at the top, which is found to maintain a lower temperature in the summer, but has some disadvantages in case of rain.

Garbage Destruction.

At each camp the contractors have built a furnace for the destruction of the garbage and refuse from the kitchen for the dining camps. This garbage furnace is very simple and quite effective. It is made by digging two trenches, each about 10 ft. long, 1 ft. wide, and 1½ ft. deep, intersecting at right angles. Over this intersection an ordinary oil barrel with the bottom knocked out is placed, and instead of the bottom, pieces of ¼ x 1½-in. flat iron are laid across the top of the trench to form a grate in the bottom of the barrel.

The tops of the trenches adjacent to the barrel are then covered over with boards, upon which clay is packed to a depth of a foot or more, leaving at the end of each trench an uncovered hole about 1½ ft. long. The barrel is also enclosed in clay clear to the top. When the clay has dried, fires are started in the holes at the ends of two of these trenches, depending upon the direction of the wind, and the heat bakes the clay around the barrel and over the top of the trench and burns out the wood lining. The garbage is then burned by dumping it into the clay barrel, starting a big fire at one end of any trench and closing the other trenches so that the flame and smoke pass through and destroy the garbage. Proper sanitary conveniences are provided at each camp, and free use is made of chloride of lime and other disinfectants, the trench system being used.

All the meats used in the camp are kept in screened houses near the cook shack, and at each camp there is an ice house, which is filled from local sources.

Water Supply.

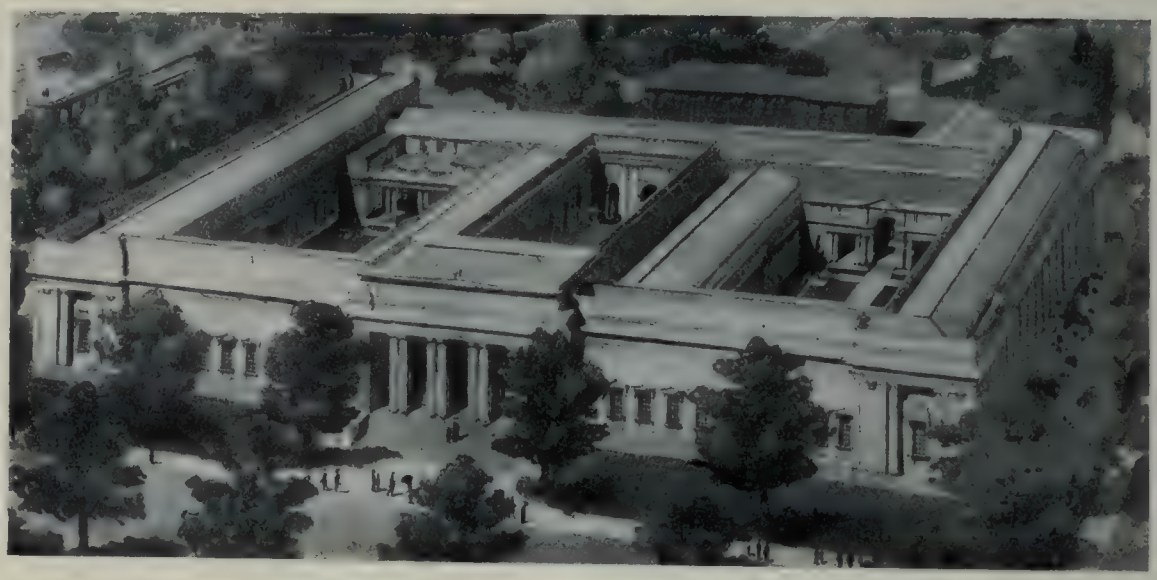
The water supply for the camps is looked after very carefully. At most places it is possible to secure good water from driven wells of only moderate depth. In other places it has been necessary to use the swamp water and filter it through sand beds. A great deal of care is taken to prevent the pollution of water source, the men being all instructed in regard to the danger thereof, and added precautions being taken by the way of frequent patrolling by the district's police organization. No cases of typhoid or other communicable diseases have so far developed.

At each camp the contractors take particular pride in attempting to make the surroundings comfortable and attractive. At best it is a very unlovely country in appearance; the timber, mostly spruce and scrub, is neither heavy nor imposing, and there are very few places where the ground is dry around the camp. In some places a number of small spruce trees have been planted along the front of the camps, and the muskegs and roots have been dug out and good drainage provided there.

There were altogether twelve such camps in use during the past season, six of which were on the work of the Winnipeg Aqueduct Construction Company, the other six being similar in general design and on the works of the J. H. Tremblay Company and Thomas Kelly & Sons, altogether accommodating a force varying from 500 to 1,000 men. The houses were neatly painted and made throughout of tongue and groove planed lumber.

Toronto to Have an Imposing Art Gallery

Work has at last been started on the art museum for the city of Toronto. The construction of this building, however, will cover a period of years, the work being proceeded with only as sufficient funds are received through public subscriptions or otherwise. The section which is now under way comprises three galleries, which will cost some $60,000. Two of these are 32 feet square and the third 32 feet by 73 feet. One wall, which will be permanent, will be built of cut stone, while the other three will be of a temporary nature, as they will be absorbed in the building as further sections are added. The structure will be entirely fireproof. The floors will be of tile and marble. The site of the museum was the gift of the late Professor Goldwin Smith, and extends along St. Patrick street, between Beverley and McCaul Streets.



Toronto's proposed art museum, on one section of which work has been started.

Dr. Wallace Addresses Manitoba Branch C. S. C. E.

Dr. Wallace, professor of geology in the University of Manitoba, addressed the regular meeting of the Manitoba branch of the Canadian Society of Civil Engineers on Oct. 5, in Winnipeg. The lecturer dealt with the present stage of mining development in the province. Interest in metalliferous deposits was confined to three districts: (1) The Rice Lake area, (2) the district north of the Pas, (3) the Star Lake area.

The Rice Lake area now consists of four separate fields—the original Rice Lake area, the Gold Lake area, the Long Lake area, and the area north of the Hole River. The only development work is in the original Rice Lake area, where several shafts have been sunk to the 100-feet level, and some drifts have been run; and in the Gold Lake district, where on the Gold Pan and Moose properties depths of 125 feet have been reached. In the Long Lake district veins have been very thoroughly stripped, but no sinking has been done. North of the Hole River work has been confined entirely to stripping. The veins in all parts of the field occur in very pronounced shear zones, which are presumably persistent vertically, as they are laterally. They are, however, narrow. Copper sulphides occur at the surface, associated with gold in gold showings. The copper sulphides give place in depth to pyrite. As a rule, the gold occurs in microscopic grains, unconnected with the sulphides, though sulphide concentrates also give good values. An interesting feature in the Long Lake area is the occurrence of very promising veins in the granite, more than a mile from the contact.

North of the Pas a belt extends over 120 miles from west to east, the centre of the belt being over 60 miles distant from the Pas. The deposits in this belt are of two kinds—(1) sulphide bodies, (2) quartz veins with gold. The sulphide bodies have attracted widespread interest. They have been formed by impregnation in zones of weakness, and are consequently irregular in shape, and discontinuous. They are also somewhat readily weathered, and occur in valleys, many of which are drift-covered. Careful prospecting will, therefore, be necessary in order to locate all the sulphide bodies. The ores are chalcopyrite, zincblende, galena, arsenopyrite, and pyrute, with gold. Two of the deposits have been fairly thoroughly prospected by diamond drilling, and are of considerable extent. It will be necessary either to erect smelters in the district or to export the ore to smelters elsewhere. The most promising quartz veins strike north and south on the east side of Herb Lake, near the eastern end of the belt. They are fairly wide, but very lenticular. One vein has been followed 1,800 feet. The country rock along the walls is very extensively mineralized with arsenopyrite, which is also the chief sulphide in the veins. The veins have been thoroughly stripped, but no sinking has yet been done.

In the Star Lake district a fahlband of conglomerate and quartzite has been extensively impregnated with pyrrhotite and arsenopyrite. Irregular veins and stringlets of quartz, which traverse the fahlband, carry high values in gold; and into the whole fahlband gold has been introduced, but in low values. On one property there is a very complete set of buildings, but new mill machinery must be installed. The underground development is by no means extensive. Elsewhere de-

velopment work has been confined to stripping and the sinking of shallow pits.

The lecturer emphasized the fact that mining operations were frequently retarded because the conditions of sale which prospectors demanded and those which mining companies were willing to offer were dissimilar in nature. He suggested that if development companies were organized to take over prospects and develop them to the stage where values could be approximately estimated, prospects of real value would have a much better chance of becoming producing mines.

C. N. Ry Station at Montreal

The Canadian Northern Railway will shortly call for tenders for the construction of a temporary station, chiefly of concrete, on Lagauchetiere Street, Montreal, in connection with the Mount Royal tunnel. Warren & Wetmore, New York, are the architects. It had been contemplated to build a very large terminal on Dorchester Street, and Warren & Wetmore made preliminary plans, but owing to the outbreak of war, the scheme was postponed; it was then decided to put up a station at Lagauchetiere Street, which will enable the tunnel to be opened, it is anticipated, about May. The excavation of the terminal site will be commenced next month, the material being conveyed through the tunnel in cars drawn by electric locomotives.

The citizens of the progressive little city of Prince George are looking forward to the speedy completion of their new waterworks and electric lighting systems, which are being installed under the direction of H. K. Dutcher, of DuCane, Dutcher & Co., engineers, Vancouver. About six miles of 4-in., 6-in., and 8-in. wood pipe have been laid. Water will be taken from the Nechako River, within the corporation limits. The power plant for pumping and electric lighting will consist of two semi-Diesel engines of 150 h.p. each. The total cost of the two systems will be about $80,000. It is expected they will be in operation by Dec. 1st.

With the co-operation of Harvard University and the Massachusetts Institute of Technology, the Barber Asphalt Paving Company has established at these institutions a fellowship for research in asphaltic materials and their uses. The fellowship is to be known as "The Clifford Richardson Fellowship." Mr. Richardson is a distinguished alumnus of Harvard, and this, taken in connection with his contributions to asphaltic highway construction, and his work in the chemistry of bitumens, makes the designation of the fellowship particularly appropriate. The appointment of the incumbent of the fellowship and the choice of subjects for investigation, as well as the disposition to be made of the results of such investigations as may be undertaken, are to be decided by the Institute faculty or the joint committees of the University and the Institute having control of engineering work.

Trade Publications

How to Maintain Concrete Roads and Streets—Hints on remedying cracks, holes and depressions in concrete roads. Published by the Portland Cement Association; 3 pages, 6 x 9 inches, pamphlet.

Dwelling Houses—A Code of Suggestions for Construction and Fire Protection. This pamphlet incorporates construction specifications intended to properly protect dwelling houses against fire. Published by the National Board of Fire Underwriters, New York; 115 pages; illustrated.

Fundamentals of Reinforced Concrete Design—A lecture prepared by Ernest McCullough, chief engineer, Fireproof Construction Bureau, for the short course for manual training and vocational teachers held at the Lewis Institute, Chicago, June 26 to July 1, 1916. Published by the Portland Cement Association; 18 pages, 6 x 9 inches; illustrated.

The Concrete Road—Paper prepared by Edward N. Hines, chairman, Board of County Road Commissioners, Wayne County, read before the meeting of the Portland Cement Association at Detroit, September, 1916. Deals with general features of concrete roads as exemplified by those of Wayne County. Published by the Portland Cement Association; 13 pages, 6 x 9 inches.

Mainly Constructional

East and West—From Coast to Coast

Western Canada White Lead, Limited, has been incorporated with a capital of $40,000, head officse at the city of Vancouver, B.C.

It is understood that the request of the Kingston, Ont., plumbers for an increase in wages from $3.00 to $3.50 per day has been granted.

The New Westminster Foundry Company, Limited, has been incorporated with a capital of $10,000, head office at New Westminster, B.C.

The Universal Smokeless Heat Generator Company, Limited, has been incorporated with a capital of $50,000, head office at Victoria, B.C.

Building operations in the city of Quebec have been active this season. For the six months, April to September inclusive, buildings have been erected involving an expenditure of $1,694,194, as compared with $1,419,943 during the same period last year.

A largely attended meeting at Whitby, Ont., recently, organized a branch of the Ontario County Good Roads Association for that town. The chairman and the secretary were authorized to arange for a big meeting during the session of the county council in November.

A contract for an addition to the St. Eusbe School, Amity Street, Montreal, has been let by the Catholic School Commissioners to Durocher and Archambault, at $152,400. The plans are by Messrs. Vandal & Gascon and Messrs. Venne & Labelle, associate architects. The addition will be three storeys, of brick and stone construction, concrete foundation and Barrett roofing.

The Querbes Academy at Outremont, Que., which has recently been opened, is a very fine building where the most modern facilities for the physical as well as the mental training of boys have been provided. The cost of the building is about $200,000. It is of fireproof construction. Its architecture is somewhat of a departure from the usual severity of style considered suitable for schools.

The total value of the building permits issued throughout the Dominion during the month of September this year was $3,401,655, as compared with $2,435,148 in the corresponding month last year. It is in the West that the biggest general increase is registered, 17 cities showing an increase of 130 per cent. In eastern Canada the total for 29 cities was $2,378,650, a 20 per cent. increase over September, 1915.

The total for the first nine months of the year is 9 per cent. above the corresponding period last year.

A recent fire totally destroyed a frame structure, 225 by 50 feet, on section 2, Welland ship canal, erected and owned by Baldry, Yerburgh & Hutchinson, contractors, and used as engine house, machine shop, blacksmith shop, and storehouse. All the contents were destroyed, except the locomotives, which were moved out. The machine shop was one of the best equipped on the canal. The loss will be in the neighborhood of $40,000, only partly covered by insurance.

The value of building permits issued in Oshawa, Ont., during 1916 compared with that of 1915 follows. The total is $325,215, as against $52,625 for the corresponding period of last year:

	1915.	1916.
March	$ 2,075	$ 2,525
April	9,350	12,115
May	25,000	25,000
June	450	58,750
July	6,000	85,600
August	7,050	41,225
September	2,700	100,000

The proposal of the Toronto Terminals Company to build steel bridges over Yonge and Bay street crossings in Toronto and postpone the construction of the railway viaduct for fifteen years has not met with approval. The city, the Harbor Board and the Board of Trade will insist that the railways proceed with the viaduct within a reasonable time. It is possible, however, that a compromise may be made, and that wooden bridges may be erected at Yonge and Bay streets and employed for a period of five or six years, until the time may seem opportune for the building of the viaduct.

At the recent annual meeting of the Toronto Housing Company reports were presented indicating that the past year had been a successful one for the corporation. All of the 250 apartments belonging to the company are let, and the rents for the 12 months amount to $54,400. The meeting was addressed by Mr. G. Frank Beers, who declared that the solution of the housing problem in urban municipalities would be found in the adoption and enforcement of town planning regulations. The meeting passed a resolution authorizing the directors to memorialize the provincial government urging the enactment of town planning legislation.

Mr. W. Sanford Evans, chairman of the Georgian Bay Canal Commission, was present at a recent luncheon of the Canadian Club at Hamilton, and delivered an address in which he discussed marketing conditions in Western Canada, showing the need for a new canal linking up the West. He states that the feasibility of the canal had been passed upon by engineers, but that it was said the cost would be $125,000,000, and the question arose whether it would be advisable to spend that amount. The commission would not meet again until after the war, he said, but in the meantime he was working along gathering information and statistics to see if the expenditure was justified.

It is reported that six of the highest city officials of Montreal intend leaving the municipal service at the end of the year. They are: Paul E. Mercier, chief city engineer; John Barlow, city surveyor; Senator L. O. David, city clerk; J. Tremblay, chief of the fire department; J. Arnoldi, city treasurer; Justinien Pelletier, city comptroller, and auditor. As to the reasons given by each for his resignation, old age or sickness is the most common. In the case of Engineer Mercier the report may be somewhat premature, but it is said he is disgusted with city hall methods and interference of aldermen and controllers in matters which they do not understand. All of the officials who are resigning, with the exception of Mr. Mercier, are entitled to their pensions.

The municipal expenditure in Stratford, Ont., shows a considerable decrease this year from the year 1915, as the board of works has adopted the policy of retrenchement on account of the war. Up to October 3 the work handled by the engineering department has cost approximately $43,500, including $16,500 for improvements. Last year the department's expenditure during the same period was $114,060, of which amount $67,500 was for public improvements. The improvements this year have included the laying of sidewalks, road improvement, construction of sewers, both for storm water and sewage, and the laying of a few water mains. Culverts were also constructed on Mornington Road and Regent Street. All the roadways constructed this year were of Tarvia. Some of the work authorized this year has been delayed on account of shortage of labor.

Concrete work on a big storm sewer in Stratford, Ont., has just recently been completed by the contractor, W. M. G. Davies, who has carried out practically the whole undertaking since its inception four years ago. This sewer stretches virtually across the city, covering in the Erie, Romeo and Collegiate creeks, and the cost is in the neighborhood of $55,000. The entire work is of monolithic construction and is declared by City Engineer Manson to be altogether satisfactory. The Romeo section of the sewer is egg-shaped, and is 6,800 feet long, varying in width from 5 to 9 feet. The Erie arch is 2,000 feet long, 9 feet wide and 5 feet high, while the Collegiate section is 1,400 feet long, 9 feet wide and 6 feet high. The concrete ranges from 10 to 12 inches in thickness at the top and is about 2 feet in width at the foot of the wall. The bottom is V-shaped and at the thinnest measures 6 inches.

Personals

Mr. C. H. Rust, city engineer, Victoria, B.C., recently addressed the Rotary Club of that city and described interesting features of the sewer and waterworks systems.

Mr. A. E. Foreman, assistant city engineer of Victoria since 1912, is leaving that city's service on November 1. During Mr. Foreman's four years in his present position he has, in addition to his other duties, introduced a very accurate cost data system which is said to have greatly increased the efficiency of the engineering department. A short article by Mr. Foreman on this subject appeared in the Contract Record of October 4. Mr. Foreman is a graduate of the 1903 engineering class of McGill University. Later he was secretary and manager of the Concrete Engineering and Construction Company, of Vancouver, and for a short time was a member of the firm of Dutcher and Foreman. In 1910-11 he was resident engineer of construction on the concrete power dam at Revelstoke and from that date until his appointment to the position he is just leaving, he was supervising engineer of the Dallas road sea-wall and construction engineer at Smith's Hill reservoir. Mr. Foreman is a member of the executive of the Victoria Branch of the Canadian Society of Civil Engineers.

Obituary

Mr. John Aylen, an Ottawa civil engineer who had been working on the Hudson's Bay Railway, was found dead recently in a Winnipeg hotel. He was fifty years of age.

Capt. Frank Ross Newman, who for three years previous to his enlistment had held the position of local manager for the Canadian Fairbanks Mose Company in Toronto, has died of wounds in a London hospital. He joined the Queen's Own Rifles on October 14, 1914, and one month later was attached to a Toronto overseas battalion with the rank of captain.

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Education Through Advertising

THAT organized publicity campaigns have had a very far-reaching effect in fostering the use of many of the present popular building materials was pointed out in an editorial published in the Contract Record of September 27. Nation-wide advertising of an educational nature has been primarily responsible for putting prominently before the public the advantages pertaining to structural products and certain construction methods. How else, for example, except by publicity would it have been possible to bring the advantages of reinforced concrete before builders? This branch of construction has developed in less than a decade from a novelty to an accepted standard, simply because the leaders in the field did not hesitate to use the forces of publicity in their sincere efforts to place valuable information in the hands of architects, engineers, contractors and owners. And it is as true of many other lines that the popularity and widespread use of their products is due in no small measure to the organizations that their manufacturers and distributors have formed for no other purpose than to publish abroad the advantages of their wares.

In our previous editorial referred to, we suggested to other manufacturers, those who are not now associated for the purpose of organized and educational appeal, or whose organizations are dormant and inactive, that they take steps to remedy the disadvantages under which they are laboring—for they are real disadvantages. Organized educational advertising pays and manufacturers must realize this, if their products, more especially new and untried ones, are to attain any measure of success in the face of strenuous competition and other new products energetically impressed upon the public.

A recent editorial in our contemporary, "Engineering and Contracting," discusses this matter of educational advertising and its influence on building, and urges that as advertising has come to be more and more truthful, it should become more instructive, more educational, and the result will be ideal advertising. This journal points out that already many advertisers are setting forth costs and giving hints as to the best ways of using their products under given conditions Some catalogs, for example, are veritable text books, full of exceedingly useful information. The advertising pages of journals contain suggestive photographs and text, and while there is much room for improvement, the march is steadily and rapidly onward toward ideal educational advertising.

"In the building field certain manufacturers—big men of far vision—have been conducting publicity campaigns of educational nature. We wonder whether many of our structural engineering and contracting readers who are designers or builders of reinforced concrete, steel and other fireproof buildings, realize to what extent they are indebted to the advertising that these manufacturers have done. When you see the nation-wide exploitation of cement, tile and reinforced concrete structures, when you read the advertisements of modern plumbing, heating and ventilating apparatus; when you note the publicity given to fireproofing, both by manufacturers and fire insurance companies, it will be well if you divest yourself of the common idea that all this advertising produces merely a profit for the advertisers. If it is successful advertising it must be truthful. If it is truthful, it must win purchases because it benefits the purchaser. If it benefits the purchaser it undoubtedly does as much good for the public as it does for the advertiser. Indeed, it is safe to say that for every dollar expended in advertising the public gains many dollars in efficiency. A bargain that is a good bargain is always profitable to both parties to the transaction. All co-operative effort is collectively profitable and the bargains between two parties are merely devices for splitting up and sharing the gain resulting from co-operative effort."

"Modern Building," discussing this same question states that people do not realize that publicity is one of the principal underlying causes of the rapid advance in building methods. Everywhere—in the workshop and in the home—is seen the influence of publicity on building. "Few of the public or of the building world realize the service which progressive manufacturers have rendered in influencing better methods of build-

ing. Courageously and unhesitatingly these men have borne the expense of important educational work, deriving for themselves only those incidental benefits that come from the use of better methods. It has taken big men with big ideas to do work of this kind and it is no wonder that many of them have developed big organizations. When the whole story of modern building is written, you will find an important place is occupied by these broad gauged manufacturers who have unsparingly used the forces of publicity in bringing their improved methods before prospective builders. Their influence, more than any other single factor, is responsible for the high class of our modern building construction."

The Engineer's Defects

ELSEWHERE in this issue, an eminent engineer, Mr. J. A. L. Waddell, discusses those things that can best be done to secure the advancement of the engineering profession. This article is exactly along the line of what the Contract Record has been hammering at for a long time. We have frequently expressed an opinion that there is urgent need for engineers as a body to exert such concerted efforts as will advance the interests of the profession and secure the recognition that is their due. In the paper referred to, the author points out the alleged deficiencies of the engineer's make-up that preclude him from reaching the highest goals of success, and suggests remedies that will overcome the difficulties, defects and general undesirabilities connected with the profession.

What can best be done to secure the recognition of the engineering body, depends, of course, on what interests that body have. Fundamentally, there is an inseparable bond between the interests of the engineering profession and the larger interests of the public. It appears to us that the paramount reason for the engineer is for the progress of mankind. It is self-evident, then, that the augmenting of the effectiveness of the profession can be secured primarily by increasing its usefulness to humanity. As we have often urged, engineers must interest themselves to a far greater extent in public affairs, but at the same time the general public must be induced to appreciate the engineer's real function in society, and the accomplishment of this is the first effective step to be taken.

To impress the public with the advantages of the engineering methods of doing work calls for concerted and co-operative efforts on the part of the great bodies and associations of engineers. Individual efforts are also no less availing or necessary to broaden the status of the engineer, but group efforts are usually more conclusive and more prolific of result. Recent action on the part of our Canadian engineers seems to indicate they are not asleep to the possibilities that are open to them and that by stern appeal to the public sense of duty they will be able to make themselves recognized as a force no less potent than the force and usefulness of other professions.

The Measure of Efficiency

"How may the efficiency of a man at his daily work be measured?" A very good answer to this was given by Mr. Robert E. Meadows, in a paper on "The Human Factor in Business." He said the efficiency of a workman or assistant could be measured by the amount of supervision he needed in his work. The more supervision a workman needs the less his value in whatever capacity he may be acting. There are two factors necessary to such a happy state of affairs. One is that the delegation of responsibility should be coupled with a delegation of power to do things which may be necessary, and the other is that the assistant should be prepared to accept responsibility for his own decisions. It is no good to hold an assistant responsible for the running of a particular department if he is to be subjected to constant questioning or interference, or if he has to obtain permission to carry out minor repairs and alterations which are obvious or desirable. On the other hand, the assistant must not only be prepared to act with decision, but must study the conditions of his work and improve his technical knowledge as much as possible, so that when he is called upon to act on his own responsibility he may do so with confidence, fully prepared to justify his action if need arises. The good chief has plenty of big things to think about, and he is usually grateful to assistants who can relieve him of anxiety or worry in regard to the small things. In fact, he measures the efficiency of the staff by the amount of supervision he has to exercise over their work.

Canada's Changed Financial Position

There is no more striking evidence of the changed conditions in our international financial relations than the participation by leading Canadian financial institutions in the loans of foreign governments. Until the war began it was deemed impossible to attempt any large financial operations without enlisting the aid of foreign capital. For several years preceding the war the country was buying an increasing proportion of its own issues, but it never reached the stage when a large issue would have been deemed possible of absorption by the country without outside assistance.

Canadians, however, are now finding funds not alone for large loans of their own government, but are investing in the bonds of the British, French, Italian and Russian governments. Instead of the financial catastrophe which many pessimists predicted for Canada the country has come through a period of unparalleled stress and anxiety with its credit stronger in the markets of the world than ever before.—Bradstreets' Bulletin.

Who Wants a Permanent Job?

"Unless the members of the society are deceiving the secretary maliciously, they are all, or very near all, profitably employed. At least, it is like the old job of hunting for a needle in a haystack to find a man now when a position is open.

"To be sure, many are but 'temporary positions,' but when you get to the bottom of the whole thing there are no others. And who of us wants a permanent job, anyhow?

"I well remember seeing a gray-haired draftsman packing his tools and books preparatory to leaving a 'temporary position' which he had accepted a short nineteen years before. When he found that it promised to merge into a permanent one he quit—and you would, too, wouldn't you?"—Bulletin, Oregon Society of Engineers.

At a recent meeting held at Oshawa, Ont., a local good roads' association was formed to help along in the general scheme for better roads in the county of Ontario. There was a large gathering and much interest was shown in the movement for road improvement. The following officers were elected at the meeting: Chairman, Fred W. Cowan; Vice-chairman, T. B. Mitchell; Secretary-treasurer, W. G. Warden.

Many Structural Failures Due to Poor Sand

A TALK on the testing of sand, principally in relation to its use in concrete, was given by Mr. C. R. Hazen, vice-president of Milton Hersey Company, Ltd., at the luncheon of the Montreal Builders' Exchange, on October 26th. Mr. John Quinlan presided. Mr. Hazen's paper, which was illustrated by a number of samples, is as follows:

"Montreal is fortunate in having available for the contractor's use a very high grade of sand, provided he is willing to pay for it. The trouble is that when a contractor starts to excavate for a cellar or a basement and finds a few feet beneath the surface a bed of sand, he is very much tempted to use it in making his concrete for the walls because of the low cost. It is astonishing how good a sand will look to the contractor when he obtains it in this manner and when he compares it with that supplied by one of the sand companies, upon which he has to pay cartage as well as freight and a profit to the dealer. A few years ago the engineer of the Montreal and Quebec Southern had occasion to instal a twenty feet concrete culvert on one of the lines below Sorel, and he found in the immediate neighborhood a pit of sand which appeared to be sufficiently good for his purpose. The sand in question was fairly coarse, quite free from loam or clay, had a sharp feel, and was physically, to all outward appearances, a fairly good concrete sand. Without investigation the sand was used, and the entire job put in with it. The work was completed towards the end of September. Immediately afterward the weather turned cold and rainy, and no further attention was paid to it, until the following spring. When the workmen came to loosen off the forms they found that the concrete had failed to set up, after a period of approximately seven months. Only a few boards were removed because of this condition. Samples of the concrete were taken and brought to the Milton Hersey Company's laboratory for examination, the engineer suggesting that the concrete had been made from poor cement. He was asked to obtain samples of the sand used, and tests were started with a cement of known value which had been tested and its tensile strength fully determined. The cause of the trouble soon became apparent, and lay entirely in the sand. The briquettes made were so weak that they could not be broken at the end of a month. The engineer had followed the common custom of blaming the cement for the trouble. Cement, by the way, in these days is a very high grade material, and it may interest some to know that the cement made on the Island of Montreal is as good, or better, than any made anywhere in America. There is no deposit of cement rock of which we are aware as uniform or satisfactory for making cement as the Trenton limestone deposits on the Island of Montreal.

Results of Faulty Sand.

"Part of the earth with which the culvert had been covered was removed as the warm weather of June came on, so that the sun and air could get at it, and it was allowed to stand, as the work had cost a considerable sum. The heat of the summer weather eventually caused it to set up, but it was September again, or a full year after the work had been placed, before it became sound and strong. We might add that trains are running over it in perfect safety to-day. It is rare, however, that work may be left in this manner, as such a delay would be much more costly in an ordinary building operation than to rip out the defective work and replace it at once. The tearing out of defective work is apt to be costly and provoking to all concerned, and it delays the work and too often holds back more than one contract. Another instance of this same character occurred in the erection of the Waterman fountain pen factory. The contractors were making splendid progress with the job, and had been using a local pit sand. One day the engineers came in with some samples in considerable alarm, stating that they had put in seven or eight sections of reinforced concrete flooring and a number of pillars which would not set up, and asked the writer to come over and inspect the job. After going over it thoroughly with the engineers the conclusion was reached that we had to do with pretty much the same conditions, and in order to avoid delays it was necessary to tear out this defective work and replace it. Now, if either of these engineers had taken the precaution to test the sand before they put it into the work they would have detected these defects and avoided them entirely.

Causes of Failures.

"It is astonishing how many failures of concrete are brought to our attention to determine the cause of the failure. Fully nine-tenths of these are due either to faulty or negligent work on the part of the foreman in charge or his men or to faulty sand. Two thirds of the blame put upon cement is really due to the contractor's not finding out whether the sand is good or not before using it. There is no objection to the use of a sand found in an excavation by a contractor provided it is good sand for the purpose, but the contractor should take the reasonable precaution to find out what its qualities are before using it, and we want to urge the necessity of having sand examined, instead of taking the chance on its being suitable. The cost is small, and it is the best kind of insurance that one can take. It is a curious thing that to the average contractor sand is just sand. Sometimes it is sharp and coarse; sometimes it is round and coarse, and sometimes it is fine, but never in the experience of our company has a contractor raised the question or asked us to investigate the proportion of the different sized grains in a sand. It never seems to occur to them that the proportion of the different sized grains has any bearing whatever upon the strength of the concrete, yet this is one of the most important features of a sand that makes it desirable or otherwise.

Voids Should Be Filled.

"If a sand is used in which the grains are practically all of one size the percentage of voids is unusually high, and may run up above 40 per cent. If the amount of the different sized grains is properly proportioned in the sand, the voids or spaces between the grains may be cut down as low as 25 per cent., and 28 per cent. is easily obtainable. Now, to get the strongest concrete it is essential that the voids be entirely filled with cement. If sufficient cement is added to a mix to properly fill 28 per cent. of voids and the sand contains over 40 per cent., you can readily appreciate how much weaker the concrete is bound to be. The average contractor is apt to dismiss this whole question with the statement: 'If you put in sufficient cement you will obtain strong concrete.' Now, this terse statement is correct, but what is entirely sufficient with one sand

and stone mixture is insufficient in another, because of what we have just said, and, on the other hand, what is absolutely necessary for one mixture may enforce an actual waste of cement in another. We are again harping on our single tune. Have your sand tested. Not alone to see whether you are likely to have trouble with it, but to determine what is most economical to obtain the required strength. This question of voids is one that is rarely investigated and yet is one that enters directly into costs and through which considerable economies, very much worth the attention of the contractor or engineer, may be effected. The application of this is very simple, indeed, for once the sands available have been tested out and the proper grading arrived at, it merely means the purchase of, at the outside, three different sands and blending them in the mix along with the cement, the sands being chosen to give the least possible percentage of voids. It is better as a measure of insurance to test the sand before using it than to wait and test it to find out why the job has failed."

Negligence Produces Failure.

In seconding a vote of thanks, proposed by Mr. Sayer, Mr. Mann pointed out that reinforced concrete had the preference over steel for certain types of building. Great developments in the use of concrete had taken place in the last five years, and it was a good thing that those who used it should learn more about it. They had heard of failures in reinforced concrete, but these had been due not to the fault of design or to the concrete, but to the ignorance or negligence of those who used it. It was to the interest of the public that they should learn what chance they were taking with the material chosen. Practically all failures in concrete occurred during the course of construction and not afterwards. Concrete was composed of certain integral materials made up into a mass, and the longer it stood the harder it became. If the forms were stripped by men before the proper time, failure resulted; if the foreman or his workmen allowed the forms to remain the proper length of time, there would be practically no failures.

Wider Joints Should be Used in Roads Laid in Late Fall

THE new highway between Toronto and Hamilton was recently opened for traffic. With the exception of a section from Mimico to Toronto, the roadway is practically complete. One-course concrete construction has been followed, using a mix of the proportion 1:1½:3, the coarse aggregate being crushed limestone. Excepting in the village of Oakville, the roadway is 18 feet wide. In this place it is 50 feet and 30 feet wide. Joints have been placed at 35-foot intervals, the joint material consisting of two layers of bituminated felt, enclosing a bituminous filler, with a total average thickness of one-quarter inch. These joints were made by staking the filler against a 1-inch board, care being taken to ensure a vertical position. They were placed before any concrete was laid near them and the board and stakes were not removed until concrete had been laid six feet beyond the joint.

As previously announced, trouble has been experienced with some of these joints, due to heaving of the slabs. Of the work performed in 1915, recent inspection showed that about 94 per cent. of the joints caused no perceptible jar; 4 per cent. caused a noticeable jar; and 2 per cent. caused a serious jar. All the latter, in which the heaving in some cases was as much as 2½ inches, were found to be inclined from the vertical when chiseled through, and about half of them had water in the subgrade beneath the joint.

Work Done in Late Fall Failed

Upon comparison of the work performed after the middle of October with that done during the whole year, an apparent explanation is found. The work done subsequent to October 15 comprised 31.5 per cent. of the entire year's work, and 41 out of the 42 joints which heaved seriously were in sections laid after this date; also 65 of the 85 joints causing only noticeable jar. In fact the nature of the joints formed a fairly sure guide of the date of concreting. During this period the temperature was, on several days, below freezing at some time, though no concrete was actually laid at such temperature.

From these results it may be concluded that owing to the low temperature at which the concrete was laid, combined with the extremely and unusually wet weather occurring during the fall of 1915 and spring of 1916, setting did not take place properly and the usual contraction upon drying-out did not occur, due to the lowering of the temperature. The excessive wet weather may have caused an unusual amount of expansion. At any rate, there was insufficient space between the slabs to take care of the expansion during the following summer. This would seem to indicate that for late fall work under conditions of climate such as we have, it would be advisable to use a wider joint, as well as employing special precautions in regard to workmanship. This is the confirmed opinion of the Chief Engineer, Mr. H. S. Van Scoyoc.

Other conditions, such as obliqueness of the joint, and the tendency of wet sand in the sub-base to expand and exert an upward pressure, unquestionably caused part of the trouble, which, perhaps, better workmanship or more favorable climatic conditions would have avoided, but the same workmanship and weather caused little trouble previous to October 15, so that much can be blamed on the fact that work was carried out during the late fall at temperatures approaching the freezing point.

Repairs

In repairing the joints, the worst ones were chiseled out, as much as four inches in some cases, and filled with a mixture of tar and crushed stone. If there was any indication that the slabs would return to their normal position, the jar to traffic was overcome by building an approach of tar and fine gravel, sometimes 18 inches in width. If there was evidence that the slab would not settle further the joints were chipped, but in no case so as to decrease the thickness of the slab by more than one inch.

What Can Best Be Done to Advance the Interests of the Engineering Profession?

By J. A. L. Waddell*

THAT there is always something to be done to advance the interests of the engineering profession goes without saying; for if the existing status of affairs were such as to make this statement incorrect, it would indicate that no improvements are being made in engineering and that none are needed—which condition is inconceivable. The question is "how serious and pressing are the conditions calling for concerted effort to improve them on the part of engineers"; and that matter should be investigated thoroughly before attempting to indicate the possible remedies.

Early in 1915 Dr. George F. Swain, the eminent engineering professor of Harvard University, and Past President of the American Society of Civil Engineers, delivered an address before the American Institute of Electrical Engineers, which was published in the Contract Record of March 10, 1915, in which he stated that, on the whole, engineers are deficient in clarity of thinking as compared with lawyers, and in both clarity of thinking and breadth of view as compared with lawyers and business men. He gave it as his opinion that the engineering profession is not appreciated at its full value, and that the engineer does not receive the recognition in public life and as a leader to which he is entitled by his attainments. Dr. Swain stated also that while the compensation of engineers has increased of late, the fees which they receive are not as large as those paid to lawyers and doctors, the reason being that the engineer does not appeal to sentiment, while the lawyer and doctor do.

Dr. Swain also remarked that the best men of the community take up law, and that "legal training and experience, on the whole, train men better to think straight and reason logically than the engineering training."

Breadth of View

Speaking of breadth of view, he says: "Here, again, there may be doubt, but I similarly question whether today, and in the past, the training of the engineer has given as much grasp of subjects and breadth of view as has the training of the lawyer and the business man. I fear that the engineer concerns himself in college, and after college, too much with the minor technical details of his profession, and does not accustom himself to study, does not take interest enough in the broad questions affecting the community in general."

Finally, Dr. Swain claims that "the fact that engineering is to so large an extent a mathematical subject is one of the main reasons why the engineer is not recognized"; also that "there is scarcely anything that tends more to narrowness of view than dealing all the time with problems which can be solved only by rigid mathematical processes, because the great questions that confront us are not mathematical; the data are shifting, variable, and the human element comes in. Therefore, the man who is accustomed to solve his problems by mathematics, and who can only do the solving in that way, finds himself at a loss in the practical affairs of life—mathematics do not apply."

These various statements of Dr. Swain's are emphatically drastic; and probably they had to be made so, if they were to effect any good purpose.

The speaker endorses many of the claims made; but he is not prepared to concede that the leaders in engineering are in any way inferior to the leaders in the other learned professions in clarity of thought, straight thinking, or breadth of view. It may be otherwise, however, with the rank and file of engineers, because their training, experience, and general manner of life are far from broadening.

Concerted Effort Needed

Certainly Dr. Swain has given good evidence, which has been fairly well endorsed by his critics, to the effect that there exist rather "serious and pressing conditions calling for concerted effort to improve them on the part of American engineers."

When two vacancies occurred in the Interstate Commerce Commission a year or so ago, the suggestion was made to one who had the ear of the appointive power that it would be desirable to have one of the vacancies filled by an engineer. He replied that such a position required a judicial quality of mind, and that the incumbent could surround himself with all the expert service needed. His answer implied that an engineer could not be found possessing the necessary judicial quality of mind. It should be stated that the man who gave this reply was a lawyer.

Once more—in one of the richest and most active counties of the Middle West a vacancy due to the death of the incumbent occurred lately in the office of county engineer; and the politicians succeeded in having the Governor of the State appoint a lawyer to the position for the unexpired term of office. Of course, he relied upon the assistant engineers to attend to all the technical work; but it is claimed that he has since stated that there is not an engineer in the entire county capable of filling the position because of its political characteristics.

Alleged Deficiencies

Do not the preceding facts constitute sufficient evidence that there is a necessity for engineers to make a concerted effort to advance the interests of their profession and to change materially those existing conditions which cause the unsatisfactory state of affairs? There can be no doubt whatsoever about the expedience of such concerted action; hence it will be well to summarize the undesirable conditions and the alleged deficiencies in the general make-up of engineers. Those most commonly recognized or claimed are the following:

(a) The importance of the engineering profession is not at all adequately recognized by the general public.

(b) Engineers as a class are not paid enough for their services.

(c) Engineers are not sufficiently often appointed to high executive positions for which their special training and knowledge eminently fit them.

(d) In most joint work where a lawyer and an engineer are employed, the lawyer is usually given the leading part and the greater compensation, and the

*From a paper read before the Engineer's Society of Western Pennsylvania.

engineer is forced to fill a subordinate position with small pay.

(e) Engineers do not take a proper interest in politics; and hence are not given any of the political plums, these going generally to the lawyers and the business men.

(f) Engineers are too modest for their own good, hence their great works are comparatively unknown outside of the technical world—and often none too well within it.

(g) Engineers as a class are lacking in the ability to speak readily and convincingly in public, and hence cannot influence the masses or guide their efforts towards the accomplishment of important desiderata.

(h) Engineers are trained too closely along narrow mathematical and technical lines and not in those which develop them broadly as men and as citizens.

(i) Engineers, as a class, do not pay sufficient attention to the proprieties, do not dress with sufficient care, do not have sufficient dignity, and rather look down upon a man who concerns himself seriously with such matters of minor importance as personal appearance and the general requirements and trifling obligations of society.

(j) Engineers, as a rule, have not a thorough command of their native language in either writing or speaking, owing mainly to the fact that they have been taught to look upon language-study as of far less importance than mathematics or technics.

(k) Engineers, because of their narrow training, are not interesting members of society, in that they are unable to converse well upon general subjects, and because they are not keen in regard to any matter that lies without the pale of their professional life.

(l) There is a lack of ambition and earnestness among the rank and file of the engineering profession, making them content with earning their comparatively small monthly wage and with living a hum-drum life, and preventing them from advancing beyond mediocrity.

(m) There is as yet no adequate general code of ethics established for engineers; and for that reason the profession cannot stand as high in public estimation as the other professions which have such established codes.

(n) There is a lack of harmony among engineers as a body (due possibly to the need of a proper code of ethics, but probably also to a number of other important reasons), which tends to hold back the progress of the profession.

(o) The field of activity of the engineer is too restricted—both from a business standpoint and geographically.

As before stated, these are the common allegations made against engineers and their vocation by both its members and the laity; but please understand clearly that they are not those of the speaker, for while he cannot deny the existence of numerous shortcomings in the engineering profession, he maintains resolutely that it is the grandest and most worthy profession of them all, in that to it are due the wonderful progress of mankind which has characterized modern times, and all the comforts and conveniences of life that make it truly worth living instead of the heavy burden which it was often claimed to be by our ancestors of a few generations ago.

The Test of Clear Thinking

The speaker does not like to confess that the lawyer is a clearer or more direct thinker than the engineer. What is the test of clear thinking? What is the measure of the value of such thought? In the engineer's case, clarity of thought is evidenced by his works successfully resisting or controlling natural forces through the adaptation of existing physical conditions to the service of mankind. The value of this service to society is proportional to the increase in the sum total of human satisfaction which it accomplishes.

In the lawyer's case, clarity of thought is best attested by the winning of a lawsuit—and in this connection it must not be forgotten that for every winning side there is also a losing side, and that, therefore, there must often have been a lack of clear thinking to the same extent as there was an existence of clear thinking. Also in the lawyer's case; the winning of a suit hinges upon a jury's verdict or a judge's decision, and not upon immutable laws of an orderly universe. The value of the lawyer's service also to society is to be measured by the increment to the sum total of human satisfaction which his efforts produce. There is satisfaction of some degree for the client whose case is won, but, on the other hand, there is equal dissatisfaction for the client whose case is lost. Hence by adding these two results it is seen that there has been no gain but simply a maintaining of the status quo.

It may be urged by some of the champions of the legal profession that the lawyer's service to society is rendered when he acts as a legislator or as a judge or other public official, and that his constructive work in framing new laws or in making decisions of record is of great benefit; but it must not be forgotten that this constructive work is later subjected to the destructive efforts of other lawyers in their endeavors to win cases for clients. Hence, considering the legal profession as a whole and the entire machinery of the courts, the principal service rendered to society by lawyers is, as before indicated, preserving the status quo.

Notwithstanding, however, anything that may previously have been intimated to the contrary, in respect to the various enumerated allegations against our profession, the speaker must confess that they all contain in them more or less of truth; and that is the reason why they have been stated by him so plainly.

Remedying the Engineer's Defects

Enough, though, has now been said about the existing difficulties, defects, and general undesirabilities connected with our profession; hence what follows will deal essentially with the remedies therefor and with the manner in which the interests of engineering may best be advanced. This subject involves two underlying questions:

First: What are the interests of the profession? and,

Second: What is the limit of their advancement?

Fundamentally, the interests of the profession are inseparably linked with those larger interests of the public which are paramount for the progress of mankind; consequently, it may be stated, without fear of contradiction, that the status of engineering can be improved mainly in one way, viz., by increasing its usefulness to humanity. This object is the true "raison d'etre" of the profession, hence the augmenting of its effectiveness will certainly react favorably upon the aggrandizement of its appreciation by the general public.

The amassing and the consumption of wealth by the people constitute the most important factor in the process of attaining the maximum of material satisfaction for both the individual and the community, which satisfaction is the true measure of national pro-

gress; and this can be secured only by a continuous and progressive development of the country's resources. With such development the engineer is directly concerned, and he is responsible in a large measure for that development. This, in a broad sense, is the service that he renders to mankind. A keener appreciation by the general public of the engineer's real function in society is greatly to be desired; and its accomplishment constitutes the first effective step to be taken in advancing materially the interests of the profession. This is the psychological phase of the problem. A proper recognition is essential so that adequate compensation may follow.

A Continual Growth in Professional Knowledge

In order that the engineer's efficiency may increase and that he may be able to respond to the growing needs of a highly complicated society, it is necessary that there be a continual growth in professional knowledge to enable him to meet such demands. Again, to render it more certain that a proper compensation will be the reward of the engineering profession, it is desirable that the supply of engineers be fairly well adjusted to the average rate of development of the country so that no large surplus will be forced into competitive methods for obtaining business. A proper balance should be maintained between the number of engineers of all lines and the total amount of capital available from time to time for investment.

We thus see that the engineering profession is especially interested in securing:

1. Proper recognition.
2. Adequate compensation.
3. Increase of professional knowledge.
4. Proper balance or adjustment of various classes and numbers of engineers to meet the needs of a developing country.

If this country is to attain to its maximum development its resources must be more highly, efficiently, and economically developed than they are now; all of which means an increasing demand on the engineering profession for generations to come. Here is the need for broad vision and clear thinking. Here is the need for a continuous adjustment and readjustment of the profession to the requirements of a growing society. It is not sufficient simply to maintain a status quo, but it is necessary that progress be anticipated; and in such anticipation the engineering profession should be leaders—not followers.

Permanently to advance the interests of humanity means to enlarge those interests in every way possible that is consistent with an increase in the sum total of satisfaction to society.

To secure greater recognition requires that a more extended publicity be given to the works of engineers and to the results and effects thereof upon the community in which those works exist. It is not sufficient merely to describe the technical details of a structure or other piece of construction work; but it should be shown how such a structure or construction affects the community by drawing a sharp contrast between the conditions preceding the improvements and those subsequent thereto. It is this that the public can best understand and appreciate.

Engineer's Interest in Public Affairs

Again, greater recognition would result to the engineering profession, were more of its members appointed on boards, commissions, committees, etc. This can be brought about mainly by the individual engineer making a practice of taking part in the affairs of the community in which he dwells. Further recognition could be secured through the various engineering organizations by making, from time to time, recommendations to legislative bodies for constructive legislation. As before indicated, greater recognition of the engineering profession and a keener appreciation of the service it renders to society must come before very much improvement can be expected in the way of remuneration. Furthermore, conditions which lead to undue competition between members of the profession are to be corrected by adjusting and readjusting occasionally the supply of engineers to meet the demands of a developing country.

To bring about any great increase in technical knowledge calls for organized and co-operative effort on the part of the members of the profession. A survey of existing technical knowledge should disclose wherein are the gaps needing to be filled. The practicing engineer can well draw on his own experience in locating such deficiencies. The filling of those gaps and the further extension of existing knowledge can best be undertaken by the numerous engineering schools working under a general program laid down by a joint committee composed of members of the various engineering societies.

New Hospital at Nelson, B. C.

The corner-stone of the new Kootenay Lake General Hospital, to be erected at Nelson, was laid on Oct. 21, with Masonic honors. The first sod was turned on June 28, since which time much difficult work on the foundations has been accomplished. When complete, the building will have a capacity of 64 patients in four public wards for medical and surgical cases, one semi-private ward, fifteen private wards, and one public maternity ward. The building will be constructed of stone and brick, the first two storeys being of stone. The basement will be devoted to the heating plant. The ground floor will contain the business offices and other administration rooms; the first floor will contain two medical public wards for men and women, five private wards, and one semi-private ward. The second floor will have the operating room, two public surgical wards for men and women, and five private wards; while the top floor will be devoted to maternity cases and will also have public and private wards. It is proposed to move the present maternity hospital a distance of fifty feet farther to the east and to connect it up with a heating system supplied from the plant in the main building. The old building will then be used as the nurses' residence.

The hospital will be equipped with an elevator for the moving of patients on stretchers, and it is planned to place no more than six beds in any one public ward.

Bombing Methods Described to C. S. C. E.

Captain G. L. Dobbin, 14th Battalion, Royal Montreal Regiment, who is home on short leave of absence, addressed the members of the Canadian Society of Engineers, Montreal, on November 2. Captain Dobbin explained in a chatty way the methods of bombing at the front, and described the various bombs, specimens of which he exhibited. He referred to the enormous improvements in this branch of warfare, stating that the British and Canadians were now superior to the Teutons. Captain Dobbin also related several humorous incidents, remarking upon the splendid morale of our troops.

The Pioneer Activated Sludge Plant

A Description of the New Installation at Milwaukee, Designed to Guide the City in the Ultimate Expenditure of $3,000,000

THE city of Milwaukee, Wis., U.S.A., was the pioneer American experimenter with the activated sludge process of sewage disposal. Their sewage testing station took up this problem as soon as this method received recognition and very exhaustive practical tests were carried out during a period of two years. In the Contract Record of April 19, Mr. T. C. Hatton, chief engineer, Milwaukee Sewage Commission, described the results that were obtained. Basing their decision on the conclusions derived from this experimental work, the commission decided to build the first unit of a large-scale plant which is being constructed for the purpose of trying out the process on a normal size unit, so that the city may be guided in the ultimate expenditure of $3,000,000 or so on its sewage system. This present unit is now in operation, cost about $60,000, and is designed to treat about 1,600,000 gallons of sewage

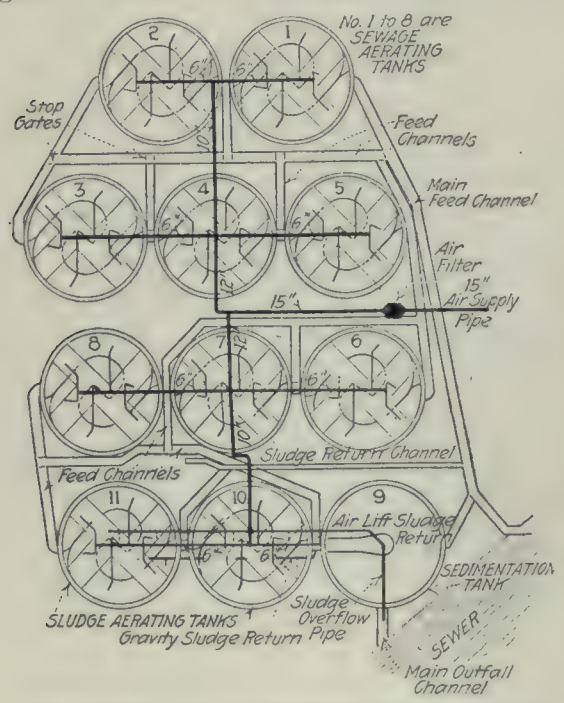


Fig. 1—General layout of Milwaukee sewage disposal plant, showing tanks, channels and air pipes.

daily with a four-hour period of aeration and a 25 per cent. activated sludge content.

One of the principal reasons for building the large plant was to determine how much the process would be affected by winter temperatures, and to study the cost and methods of overcoming this effect. Extremely satisfactory results were obtained in the experimental plant with sewages varying in temperature from 50 to 70 degs. F. As low temperatures seriously affect the efficiency of nitrifying organisms, the present plant will show the means to be used to overcome this. One important feature in the design of this full-size unit is that it shall be possible to convert the activated sludge tanks into digestion chambers for Imhoff tanks in case the new process does not prove satisfactory. This can be done by merely removing the sloping bottoms and baffle walls.

The General Scheme

The illustrations accompanying this article show the general layout and details of the system. There are eleven circular reinforced concrete tanks, 30 feet inside diameter and 13 feet maximum depth, supported on a pile foundation, due to the instability of the soil. The tanks are of the continuous flow type. Sewage and "seeded" sludge are aerated in tanks 1 to 8, by means of air forced in under a 5 lbs. pressure, the combined sewage and sludge passing from one tank to another and finally into sedimentation tank No. 9. In this tank the sludge is separated from the clear liquor by settling. The liquor passes over the circumferential weir shown in Fig. 3 to the lake, and the sludge is discharged by gravity from the bottom of a deep well in this tank, Fig. 3, to either sludge-aerating tank No. 10 or 11. From these two tanks the aerated sludge passes to a 48-inch vertical cast-iron pipe, set 28¼ feet in the ground, from which it is pumped and returned to the inlet of tank No. 1 or dewatered and used for fertilizer.

The total depth of sewage and sludge is 10 feet, and the average depth, 9 feet in the ten aeration tanks. In the sedimentation tank, the depth of tank proper and deep-well is about 35 feet. The eight sewage aerating tanks hold 45,000 gallons apiece. The sedimentation tank has a capacity of 33,000 gallons, exclusive of the 2,260 gallons held by the 4-foot cast-iron sludge pipe (deep-well) extending below its bottom.

In Fig. 2 the sewage aerating tanks are shown with curved baffles, by means of which the sewage is subjected in the first eight tanks to aeration for a distance of 912 feet. The bottom of the channels are sloped to avoid the deposition of sludge. The air is diffused by filtros plates, 78 to each tank, measuring 12 inches square, giving a ratio of diffusing surface to tank surface of 1 to 8.5. The filtros plates are set in cast-iron frames, which also serve as air supply conduits. The air capacity is 2 cu. ft. per minute per plate in tanks Nos. 1 to 8 and 12 cu. ft. per minute in tanks Nos. 10 and 11, under a 2-inch water pressure. The air is supplied by two positive pressure rotary blowers, of a capacity of 2,400 cu. ft. free air per minute each compressed to 5 lbs. per square inch and belt driven from alternating-current variable-speed motors of 75 horse-power. The duplicate set is to provide for possible interruptions. Indicating, self-recording, integrating meters measure the volume and rate of air supply, there being one meter for the eight sewage tanks and another for the two sludge tanks.

The Air Diffuser

Many experiments have been conducted with a view to determining the best form of air diffuser, and others are now being carried on. So far the filtros plate seems to give the best results. This is a composition of quartz sand and some character of cement to bind it together. The sand is ground to a uniform coefficient to give any desired porosity, and, after adding the cement, is burned in a furnace. The plates come any size or shape desired, and at any thickness. In the Milwaukee plant a plate 12 inches square by 1½ inches thick is being used, and has a capacity

for passing 2 cu. ft. of air per square foot at 2 in. water pressure. The porosity is 33.27 per cent. by voids.

The sedimentation tank is provided with a roof to prevent ice forming about the edge of the circular weir which would set up uneven currents. This tank has a radial flow. It is designed for a 25 minute sedimentation period at a 2,000,000 gallon rate. The sludge tanks differ from the sewage tanks only in having stop planks to divide each into two compartments.

Wooden rectangular troughs built part way around each tank control the direction of the flow of liquor and have stop planks to cut out any one or more of the tanks, Fig. 1. The sewage from the city passes through a 20-ft. wide open channel alongside the plant. A weir in the bottom of this channel keeps back about 3 feet of liquor and thus forms a grit chamber to allow the heavier solids from the street washings to settle. The weirs are so arranged as to provide a flow through the plant to correspond with the fluctuation of flow through the sewer and the air applied to the flow will be automatically regulated to correspond with this flow.

That portion of the activated sludge in excess of what is necessary to maintain the proper percentage in the aerating tanks is pumped out of the sludge tanks from time to time and dewatered so as to be used as fertilizer. The plant capacity under three different operating-rate schemes is as follows: (1) with 25 per cent activated sludge in the aerating tanks, a 4-hour period of aeration, a velocity of 3.8 feet per minute and a 27-minute sedimentation period—1,620,000 gallons per day; (2) 25 per cent. activated sludge, 3 hours aeration, 5-foot velocity, 20-minute sedimentation—2,160,000 capacity; (3) 20 per cent. activated sludge, 3 hours aeration, 5-foot velocity and 19-minute sedimentation—2,304,000 gallon capacity.

Results of Operation

Since the operation of the plant was commenced some months ago, certain results have been obtained which indicate that minor changes will be required as was expected. In the Engineering News, these results are summarized as follows:—

Early in the operation it became apparent that the sedimentation tank was not designed to properly meet the conditions, in that the velocity through the tank was too great and the bottom slope was too little. Instead of a 27-min. sedimentation period the indications are that about 60 minutes will be required to permit the finer floc to settle out.

The settled sludge rested upon the sloping bottom to a considerable extent, and, unless removed at frequent intervals by using a squeegee, became septic and consumed the dissolved oxygen contained in the influent. In addition to this, sludge accumulated in the 48-inch cast-iron pipe which was not removed by the air lifts, and this also became septic.

Instead of a 45 deg. slope the bottom of the sedimentation tank should not be less than a 60 deg. slope from the horizontal, and the sludge should be removed from a pipe built at the apex of the conical bottom so as to insure its constant and complete removal.

With the sedimentation tank as built it has not been possible to get more than 1,000,000 gallons of clear stable effluent per day through the plant without losing the sludge.

In order to try out horizontal-flow sedimentation, No. 11 tank has been improvised into three compart-

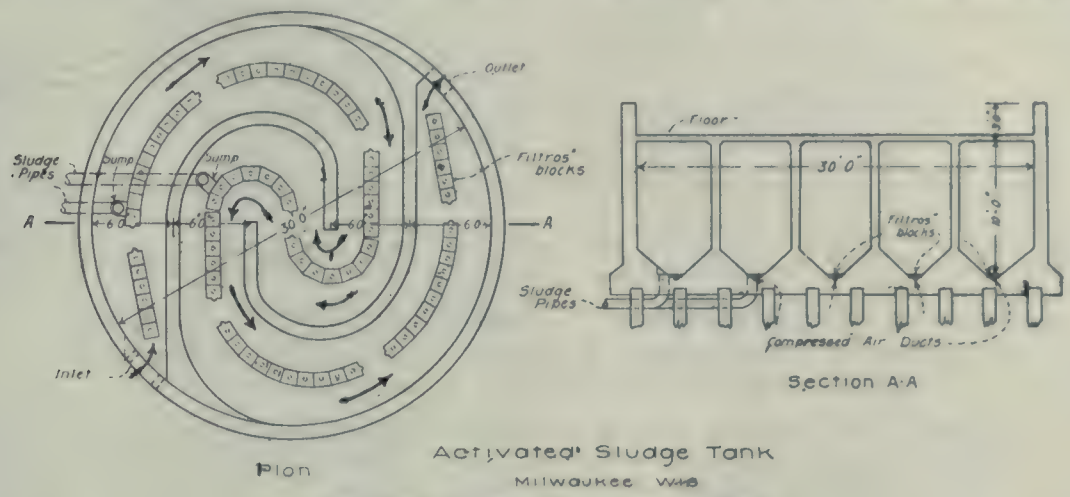


Fig. 2—Plan and section of sewage aerating tank.

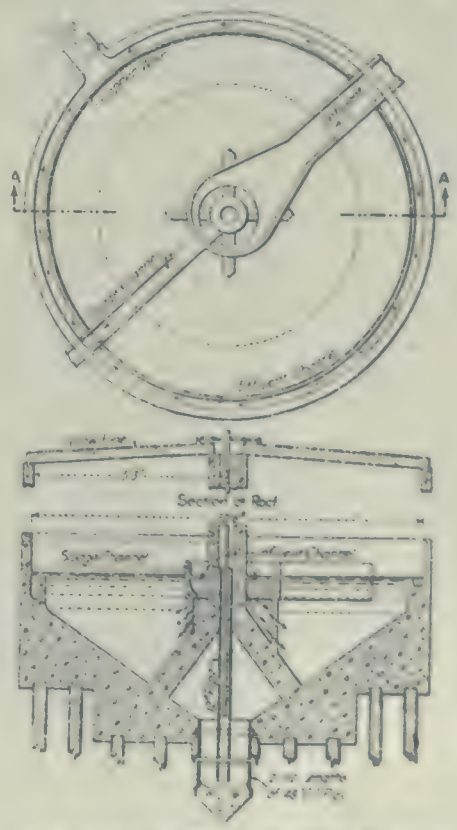


Fig. 3—Plan and section of sedimentation tank.

ments, each of which can be operated separately. So far the indications are that an average horizontal velocity of 3 ft. per min. will be sufficient to secure satisfactory sedimentation, but this figure is subject to further determinations.

In operating the large plant throughout the last seven months several important matters have been fully demonstrated, among which may be mentioned: That an increase of air pressure is required due to the partial silting up of the top surface of the diffuser plates, which indicates that provision must be made to clean off these plates at intervals.

That when the temperature of the sewage is 50 degs. F., or under, more air is required to produce an equal effluent from sewage having a temperature of 60 degs. F. or over.

That circular tanks are not so efficient as rectangular tanks either in first cost or in operation and require much more area to treat an equal volume of sewage than do rectangular tanks.

That the mixed sewage and activated sludge must not be run through conduits as the tendency is for the sludge to settle out immediately in the conduits and become septic. The sedimentation tank must be connected to the aerating tanks without conduits.

That the settled sludge must be constantly and completely removed from the sedimentation tanks to prevent septic action.

Electric Welding of Structural Steel

Will the Spot Weld Process Supplant Riveting?—The Rapid Progress of the Method Suggests its Possible Application

WILL electric welding supplant riveting in fabricating structural steel? The remarkable progress made in the practical application of electric welding methods presages successful employment of this process in connecting structural units. Certainly, at any rate, obvious advantages will accrue if welding of this nature can be placed on a practicable basis. In the "Engineering Record" Mr. G. C. Hinckley discusses this subject, pointing out the enormous advantages that will attend the introduction of electric welding, which, in view of the tendency toward the electrification of shop methods and the employment of labor-saving devices, promises to replace a large percentage of the riveting in fabricated iron or steel products. His article follows:

A decade ago the art of welding iron by means of the oxygen-acetylene flame was unknown. Electric welding is of still more recent origin. It is only within the past few years that these methods have emerged from the experimental to their present state of demonstrated practicability and rapidly broadening application in the metal trades. Welding concerns, confining their operations chiefly to repair work, have been successfully established in many of our larger cities. Lap-welded steel pipe and welded boilers and tanks have taken their places on our market in competition with the riveted articles.

Electric Welding Commercially Successful.

Electric welding has been demonstrated a commercial success in the manufacture of sheet-metal goods, automobile frames, steel window sash, frames for concrete reinforcement, etc. Its progress is marked particularly by a rapid and pronounced tendency toward the welding of increasingly heavy sections and the perfection of larger welding units, as recently evidenced by the introduction and successful operation of an electric spot welder with a capacity equal to a butt weld of 7 square inches sectional area for the field-welding of connection plates across the ends of street railway rails. There is nothing to indicate that the ultimate limit of capacity has been approximated in this machine, the probability being rather that such a limit will be controlled only by the amount of electricity economically available in any instance.

The remarkable progress in the practical application of these new methods has so far outstripped their literature and published data that the subject is marked by a dearth of definite information, resulting in a general lack of knowledge concerning the methods themselves and of appreciation of their possibilities. Lacking such detailed information, and in the absence of specific experiments and tests, it is of course impossible accurately to predict the future of these methods, especially in their possible application to new fields of industry. Nevertheless, when we consider in a broad sense their present status of efficiency and rapid growth, together with the pronounced modern tendency toward the electrification of shop processes and the universal adoption of labor-saving devices, it is logical to assume that, unless unforeseen obstacles are encountered, the electric-welding process promises within the next few years to supplant 90 per cent. of the riveting in all our fabricated iron and steel products. In the shop fabrication of structural steel such an innovation would be nothing short of revolutionary in its character and attended by enormous advantages, some of the more important of which it is now proposed to point out and discuss in a general way.

Efficiency of Welded Connections.

In the first place, let us assume that the tendency will be so to design welded connections that the welds themselves will be in shear whenever possible, much as is the current practice in riveted joints. Consider a typical connection, a girder web splice, for instance, consisting of the usual pair of splice-plates with double rows of rivets, the splice being subject to the usual tension, compression, and shearing stress, and then conceive of the rivets being replaced by a sufficient number of spot welds between the splice plates and the web. The great advantage of the welded splice, both in efficiency and economy, is immediately apparent, inasmuch as it involves no reduction of sectional area in the web or splice plates for rivet holes. It has been repeatedly demonstrated that the riveted splice cannot exceed about 80 per cent. efficiency; the welded connection, on the contrary, may be made 100 per cent. efficient, or more, depending on the total area of the spot welds, which may be grouped as closely as desired, or even joined together to produce a single large welded area. While these advantages pertain particularly to tension joints, they are nevertheless applicable in a degree to all points where rivets are now used.

It will thus be seen that the substitution of welding for riveting would result in an ultimate saving of

metal in each fabricated member, roughly measured by the difference between the present so-called "gross" and "net" sections, together with a considerable saving in the weight of details, while the opportunity for a better distribution of metal in the design of sections would doubtless result in additional economy. Eventually certain modifications in the rolled shapes themselves could be expected to result in very important saving of metal, inasmuch as the elimination of rivets would permit a more efficient distribution of metal in a great many shapes, in whose design the effective section has heretofore been subjected to the necessity for punching and reaming rivet holes, with the attendant rehandling of material in the shop, and would doubtless also eliminate fully 75 per cent. of the template-making and laying-out work. The cost of manufacturing, heating, and driving rivets would be replaced by that of operating the welding machine and also a sand-blast for cleaning the surfaces to be welded. In view of these facts it must be conceded that, if the introduction of the welding process should prove feasible, it would result in an immense saving of shop labor, and that the elimination of the punching, reaming and laying-out operations would leave a wide margin to cover any possible increased cost of the welding operation itself over that of driving rivets. In the light of results now obtaining in the welding of smaller work, there is reason for the expectation that the total shop cost of fabrication by welding could be brought considerably below that of the present methods.

Comparing, from a mechanical standpoint, the welded and riveted types of connection, it is at once obvious that the advantage lies with the weld, in which the stress coming upon the joint is immediately and simultaneously assumed by each spot weld, the amounts carried by the individual spots depending, of course, on their relative areas and positions in the group; whereas in the riveted connection the application of stress acts first to overcome friction between the plates consequent upon the initial tension in the rivets, after which the rivets take stress one by one, depending, among other things, on their varying fits in the holes. Under such action, and when subject to any considerable vibration or stress reversal, a riveted joint will loosen more or less in time, resulting in a gradual loss of efficiency and an increasing tendency toward crystallization and deterioration from rust and wear.

Uniformity of Welds.

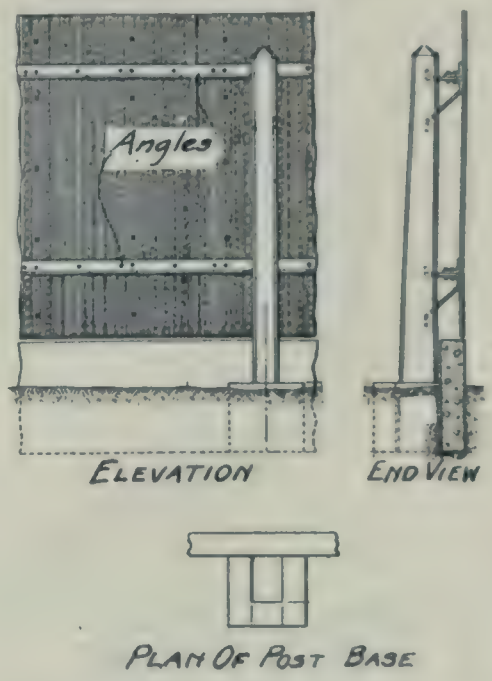
It will be contended that the nature of a welded connection involves lack of uniformity in the quality and strength of the welds, which must be met by an increased factor of safety. However, the validity of such an objection is subject to question. Inasmuch as the welding process would seem to involve no more uncertainty of uniformity than that of making and rolling the steel itself, if welding were subjected to the same systematic inspection and testing as now obtains in the steel mills, the results would be dependable in a similar degree. There is no apparent reason why the electric-welding process may not be conducted with absolutely uniform results, for once the necessary pressure, amount of current and time of application have been determined for any given thickness of plates these may readily be maintained constant throughout repeated operations.

While there is nothing in the process to prevent the continued use of the riveted field connections, the same prospect of successful welding obtains in the field as in shop work, the contractor's air-compressor plant and riveters being supplanted by a generator plant (where electric power is not at hand) and a portable electric welder, which for ordinary work should be no more cumbersome than the "bull machine" now employed for field-riveting on larger jobs.

Comparative tests of welded and riveted connections on identical members are needed to verify the foregoing contentions regarding their relative efficiencies. Investigations should be conducted to determine whether the heating due to the welding process will have any injurious effect upon the steel, with a view particularly toward ascertaining the maximum thickness of metal practicable to be welded under existing conditions and the best method of increasing this thickness. A series of tests using very thin filler plates of pure iron or other substance between the plates to be welded might be productive of interesting and valuable results. Experimental work to furnish approximate data on the costs of welding structural steel is, of course, imperative.

Galvanized Corrugated Steel Fences

Excellent use can be made of corrugated steel sheets for fence construction, especially in combination with reinforced concrete posts. The illustration shows a fence of this type which is being extensively used, especially for industrial or factory plants. The fence



consists of a concrete curbing about six inches wide and extending a foot or so above the ground surface. Post bases are cast integral with this curb, a pocket being left to take the post. The posts are of reinforced concrete, about 8 inches by 12 inches at the bottom and tapering towards the top, and spaced about 15 to 18 feet apart. Six ¼-inch bars give ample reinforcement. Flats measuring ½ inch thick and 3 inches wide are bent as shown and imbedded in the post to carry the longitudinal angles which support the sheeting. The angles are bolted or riveted to the brackets. Galvanized corrugated steel sheets are then riveted to the angles to form the fence.

Many advantages are evident for this type of fence. In appearance it is much trimmer than the average wooden fence, and it is quite efficient in preventing trespass. It is sufficiently solid and strong to resist wind and snowdrifts. The concrete curb prevents the soil from washing out, and in that way maintains a neat appearance. The maintenance cost and depreciation are low and the fence will last a long time.

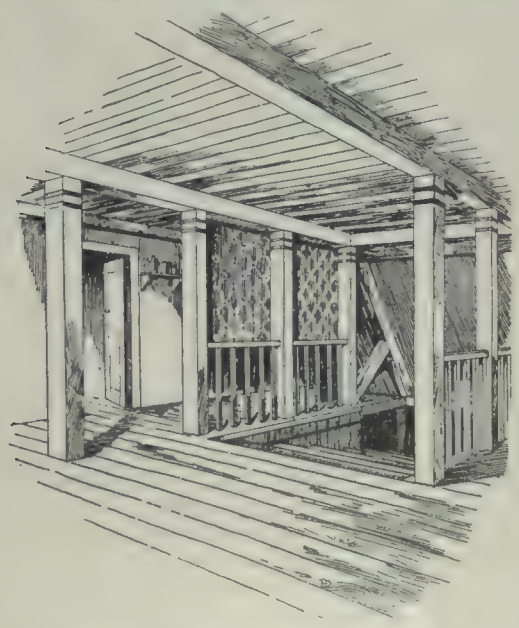
Captured German Trenches

WE frequently hear of the solidarity of German trenches and the elaboration and completeness of their finish. Two years in fixed positions have enabled our enemy to incorporate the highest degree of military engineering skill and ingenuity in the building of their trench fortifications. These have been characterized by heavy reinforced concrete and steel protections and by dugouts of a capacity to enable whole battalions to escape the terrors and dangers of a fierce bombardment. These dugouts have in many cases been elaborately fitted out and finished, and have indicated the enemy's intention, or hope, of a long stay. In a recent issue of the "Cabinet Maker" (England) there is an article from an authoritative source describing in detail the elaborate system employed in German trench architecture and illustrating the furnishing and decoration of some of the dugouts. This is of such general interest that we reproduce the article below:

Along many miles of the western front, as it was till the end of June, you can now do what seems to trench dwellers almost the utmost reach of impossibility. You can stand at your ease in the middle of No Man's Land and look at a German front trench on your right and a French or British trench on your left. As soon as you do so you feel that the outward face of each wears a quite different expression.

Contrast Between British and German Trenches.

If you now leave your first standpoint and explore the two trenches in turn, and also the support and communication trenches behind each of them, you find that the difference goes, in more than one sense, deeper still. The Allied trench looks in every way like the work of men who hoped and meant to move on before



long; the German trench looks like the work of men who hoped, or feared, that they would be in it for years. Our trench housing has been much more of a makeshift, a sort of camping out, with some ingenious provisions for shelter, but not more than the least that would serve. Most of our dugouts are just roughly delved holes in the earth, with only enough props and rafters to hold the roofs up; their floors are bare ground, with a little straw on it; their doors, if they have any, are a few odd pieces of plank with a couple of other pièces nailed across; often the floor is on the trench level, to save burrowing. Lighting is done with candles, mostly bought at the canteen, and if anyone owns an armchair or a two-foot-high mirror it is the jest of the platoon.

A Huge Straggling Village.

The whole German idea of trench life is different. The German front in the west is like one huge, strag-

gling village, built of wood and strung out along a road 300 miles long. Of course, the houses are all underground. Still, they are houses, of one or two floors, built to certain official designs, drawn out in section and plan. The main entrance from the trench level is—sometimes, at any rate—through a steel door, of a pattern apparently standardized, so that hundreds may come from the factory on one order and missing parts be easily replaced. The profusely timbered doorway is made to their measure. Outside this front door you may find a perforated sheet of metal, to serve for a doormat or scraper. Inside, a flight of from 12 to 36 stairs leads down at an easy angle. The treads of the stairs and the descending roof of the staircase are formed of mining frames of stout timber, with double top sills; the walls are of thick planks, notched at the top and bottom to fit the frames, and strengthened with iron tie-rods running from top to bottom of the stairs, and with thick wooden struts at right angles to these.

At the foot of the stairs a tunnelled corridor runs straight forward for anything up to fifty yards, and out from there open rooms and minor passages on each side. In many dugouts a second staircase, or two staircases, lead to a lower floor, which may be 30 or 40 feet below the trench level.

Completely Lined With Wood.

All these staircases, passages, and rooms are, in the best specimens, completely lined with wood, and as

fully strengthened with it as the entrance staircase already described. In one typical dugout each section of a platoon had its allotted places for messing and sleeping, its own place for parade in a passage, and its own emergency exit to the trench. In another, used as a dressing station, there are beds for 32 patients and a fair-sized operating room. A third, near Mametz, was designed to house a whole company of 300 men, with the needful kitchens, provision and munition storerooms, a well, a forge revetted with sheets of cast-iron, an engine room, and a motor room.

Furnishing the Officers' Quarters.

Many of the captured dugouts were thus lighted by electricity. In the officers' quarters there have been found full-length mirrors, comfortable beds, cushioned armchairs, and some pictures. One room is lined with glazed "sanitary" wall paper, and the present English occupant is convinced by circumstantial evidence that his predecessor lived there with his wife and child. Clearly, there was no expectation of an early removal.

Nobody who reads this should leap to the conclusion that, simply because German trench work is more elaborate than ours, it is a better means to its end—the winning of the war. No doubt the size and the overhead strength of the German dugouts keep down casualties under bombardment, and sometimes enable the Germans to bring up unsuspected forces to harass our troops in the rear with machine gun and rifle fire when a charge has carried our men past an uncleared dugout of the kind. On the other hand, if our advance is made good, every German left in such a dugout will be either a dead man or a prisoner. No doubt, again, the German dugouts give more protection from very bad weather than ours. But they also remove men more from the open air, and there is nothing to show that the half-buried German army gains more by relative immunity from rheumatism and bronchitis than it loses in the way of general health and vitality. In England troops have better health in tents than in huts, and better health in huts than in billets. For a man of sound constitution "exposure" often means something unpleasant rather than unhealthy, and it would not be surprising if the close underground villages of the Germans yielded higher figures of general sickness than our own simpler, shallower, and more airy trench shelters.

Suggestions for Fire Protection

The following suggestions were submitted by City Architect Alcide Chausse, of Montreal, at the twenty-third annual convention of the American Society of Municipal Improvements, recently held at Newark, N.J. Mr. Chausse is chairman of the Committee on Fire Protection:

Adoption of the principle of classification of buildings in accordance with fire resistive qualities.

The amplification and extension of tentative tables of test specifications for materials of construction established by the International Fire Prevention Congress, held in London, England, in 1903.

Co-operative effort among industries, looking toward the formation of a basic, fundamental building code.

That discretionary powers should be vested in building officials to vary or modify the law where practical difficulties arise in the literal enforcement, so that the intent of the law is assured; and that in case the building official declines to exercise discretionary powers, an appeal should lie to a board of technical experts.

That proper means of egress from every building should be provided in the form of enclosed stairways; that outside metal fire escapes should not be considered as a required means of egress from new buildings, and that their use should be confined to existing buildings, where other means of egress are impracticable; and that, wherever such fire escapes are used the opening thereon should be protected by metal sash and wire glass or by fire-resisting doors with proper fusible links.

That standard specifications for hollow building tile and construction be adopted, also comprising metal lath and gypsum blocks.

That the installation of automatic fire sprinklers be encouraged in all classes of public buildings and commercial and industrial establishments.

The adoption of regulations and by-laws respecting the transportation, storage, and use of inflammable liquids and explosives.

The universal adoption and use of the safety match, and legislation prohibiting smoking in all parts of industrial and mercantile buildings.

The education of children and the public generally in careful habits regarding the use of fire.

The adoption of uniform boiler by-laws.

Specifications As They Are

The following, taken from Engineering and Contracting, is, we believe, meant to be a satire on architects' specifications in which, as is usually the case, the contractor is made the "goat." However, the characters are true enough to life to be easily recognized.

General: The plans and specifications are to be taken together. Anything shown in the plans not mentioned in the specifications and anything mentioned in the specifications and not shown on the plans is to be considered as both shown and specified; and anything wanted by the architect or any of his friends, or anybody else (except the contractor), shall be considered as shown and specified, implied and required, and shall be provided by the contractor without expense to anybody but himself. If he can do the work without expense to himself, the work shall be torn down and done over again, until the expense is satisfactory to the architect.

Architect: The term architect herein appearing shall be understood to mean the architect or any engineer that he foolishly but courteously employs to assist in making trouble for the contractor.

Plans: The plans are to be considered diagramatic, and are to be followed only where space conditions make it possible to avoid so doing. Coincidence between the plans and executed work shall not be considered a claim for extra compensation. The architect is not required to recognize coincidence. Anything that is right on the plans is to be considered right; anything that is wrong on the plans shall be discovered by the contractor, and shall be made right without telling on the architect or on the bills. Anything that is forgotten or missed out of the plans and specifications, but which is necessary or required for the comfort and convenience of the owner, shall be provided by the contractor, to the satisfaction of everybody (except the contractor) and in full accord with the evident intent and meaning of the specifications without extra cost to anybody but the contractor.

Rules and Regulations: The work throughout shall comply with all rules, regulations, caprices and whims of all city, county, state, national and international

departments, bureaus and officials having or not having jurisdiction.

Materials: All the materials shall be the best of their several kinds. The contractor is expected to know and provide the best, irrespective of what is specified in detail. The architect reserves the right to change his mind about what is best. Any changes necessary to make work and material fit the mind of the architect shall be made by the contractor without extra charge.

Permits: The contractor shall obtain and pay all fees, annual dues, assessments and subscriptions to masked balls, organizations and coat and hat checks.

Guarantee: The contractor shall guarantee and does guarantee that he will keep in complete working order, anything that the architect asks him to, so long as there is more work in sight in the architect's office.

Arbiter: In case of any dispute arising as to the nature, character or extent of work shown, specified or implied, the matter will be decided by referendum and recall, after which the decision shall be set aside and reversed by the architect and designer-in-chief of the national government.

Payments: Payments, if any, shall be made on the architect's certificate. Architect's certificate shall not be considered negotiable, nor are they legal tender. When once issued, the architect assumes no responsibility for their future usefulness. Partial payments shall be made as the work progresses in the amount of 85 per cent. of the value of the work done as judged by the architect. In no case shall the judgment of the architect cover more than enough to pay the wiremen and helpers every Saturday night. The material men must take the customary chances. The final payment, if any, shall be made when everybody is satisfied (but the contractor). Any evidence of satisfaction on the part of the contractor shall be considered a just cause for withholding final payment.

The contractor shall accept and hereby does accept the conditions hereinbefore appearing, for himself, his ancestors and progenitors, his family, heirs, executors, his ox, his assignee and the stranger within his gates.

Contractors Responsible for Dry Rot

An important decision has just been handed down by the Court of Review, Quebec, which confirms a previous judgment of the superior court regarding a mill built by Peter Lyall & Sons Company for the Canadian Spool Cotton Company. It appears that shortly after the building was constructed it was noticed that dry rot had set in in a number of the timbers, and eventually the diseased wood was taken out and steel substituted. This work was undertaken by the Canadian Spool Cotton Company, who sued the contractors and architects for the sum of $98,802 as damages.

The judgment reduces this amount to $71,120.85, which the Peter Lyall & Sons Company, contractors, and Brown & Vaillance, architects, are jointly and severally condemned to pay to the Canadian Spool Cotton Company, it being held by the court that the evidence showed that the contractors had substituted an inferior class of building material, and therefore had not followed the specifications to the letter.

The contracting company are further condemned to pay to the spool company the sum of $4,098.72, because the mill had to be re-pointed. In this case it was argued by the contractors that the actual cost of pointing the building had been more expensive than the plan called for in the specifications, but the court held that it was a matter of specific performance, and, as the work was not executed in accordance with the specifications, the contractors are bound to pay the cost of having the work done over again in the manner called for. Justice McDougall also added: "We cannot sanction the doctrine that a contractor may substitute one kind of material for another. A contractor must conform to his contract."

In connection with the dry rot, it was argued by counsel for the contractors that dry rot under certain circumstances was inevitable, but the court found that the evidence did not establish this fact, and that, in their opinion, it was possible to ascertain whether or not the germ of dry rot was present in the timbers before they were placed in the building.

A Law to Avoid Public Utility Strikes

An enlistment contract for a stated term, after a probationary period for new employees, states "Engineering Record," is one of the features of a law proposed by Henry R. Towne, past president of the Merchants' Association of New York, to insure continuous and adequate service from all public utilities. Such a contract would be required between each utility and each of its employees, and would be renewable by mutual agreement. The company could terminate the contract because of misconduct by the employees, as defined by law; because of slack business, in which case the employee should have thirty days' notice, or two weeks' pay and immediate release, or because of disability or superannuation, on stated notice. The employee could terminate the contract because of valid family or personal necessity, because of sickness or unfavorable effect on health, or for cause not stated, upon fair notice, without penalty if with the company's consent, otherwise subject to fine as provided by law.

A schedule of fines for both corporation and employee would be a part of the plan. Fines against the company would be collectible from a fund created by the company and vested in a trustee; those against an employee from a fund created by the company's retention of a percentage of the employee's first wages —the company to return this fund with interest when the employee leaves the company. Several methods are proposed for the assessment of fines, which would be payable to the other party to the contract.

Employees would have a right to join any lawful organization, and could alone or in combination with others request concessions in wages or conditions of service, and the company would be required to give prompt and fair consideration to all such requests, without discriminating against any employee for participation in such requests. The employee could appeal decisions to a joint board of award, constituted under the law by joint action of the company and its employees, and both the company and its employees would have the right to appeal to an appropriate federal or state body.

During the term of any contract between the company and an employee the discharge of an employee or the cessation of services by the employee, except as provided by law and previously stated, would be an offense at law and punishable as such.

The Raymond Concrete Pile Company, Montreal, have been awarded the contract for the piling for a stack, boiler house, and pumping station for the Riordon Pulp and Paper Company of Hawkesbury, Ont.

A Typical House for Industrial Townsites

IN these days of keen competition and advanced business methods, commercial concerns throughout the country realize that if they are to forge ahead of their competitors, they must neglect no detail that will affect the output of their plants. In consequence of this fact more attention is being paid both to the living and working conditions of the employees, and in country districts and at isolated points, industrial towns and villages are springing up all over the Dominion, which are built on modern and scientific lines, conducive to the health and comfort of the workingmen and their families. A village of this nature is at present being built for the Canadian Copper Company, at Creighton Mine, and additions made to the town of Copper Cliff, Ont., and a description of a typical house will no doubt be of interest as indicating what class of dwellings are being erected by big concerns in these industrial towns, and the expenditure which is necessary. The accompanying sketches show what very comfortable accommodation can be supplied at surprisingly low cost.

All of the houses are of frame construction, but are built in different sizes and styles to suit varying conditions. These cottages were carefully designed to make them wind proof, especial care being taken around the openings, and double sheathing was used on both sides of the exterior walls. They run from about $900 to $4,000 in cost. The illustrations herewith show plans and elevations of a small type of house which the company is erecting for the accommodation of the foremen, the cost of which is about $2,000. It is 22 ft. x 23 ft. in dimensions, two storeys high, and contains six rooms—a kitchen, dining room, living room, two bedrooms and a bathroom. All of the rooms, as will be noted on the plan, are of fairly large size. There is no cellar in this particular type, and the house is built on cedar post foundation, and closed in below the first floor. The outer portion of the walls is constructed of shiplap, paper and siding, and the inner portion of shiplap, paper and 5/8-in. V-joint, built up on a framework of 2 in. x 4 in. studs. The house is roofed with best grade cedar shingles. There is a large porch in front and also one off the kitchen at the back. Stoves are used for heating purposes.

Every house in the village is supplied with electric current for lighting, and all of the two storey houses are fitted with plumbing and water services. Most of these are equipped with modern hot air furnaces and electric light fixtures, both of which are included in the price given. Each is also provided with an outshed in the rear for storage or other purposes. There are 187 buildings altogether, now nearing completion, and they will be occupied in about a month's time. This number includes a 28-room boarding house for bachelors, and a club house which has been provided for the engineers. The contract for the whole work has been carried out by the Dickie Construction Company, Toronto.

Disposal of Sludge from Activated Process

Long-Continued Aeration Suggested as a Means of Minimizing the Surplus Sludge

IN a paper presented at the convention of the American Chemical Society, Mr. G. T. Hammond discussed problems bearing on the activated process of sewage treatment and suggested aeration for treating and disposing the sludge in the same way as the sewage is treated. The amount of sludge which must be disposed of is easily the first among the problems that the activated-sludge process of sewage treatment involves. This sludge amounts to 2,000 to 4,000 gallons or more per million gallons of sewage, and the material has a water content of about 99 per cent. Mr. Hammond sees possibilities in the use of some scheme of long-continual aeration in order to minimize this surplus sludge.

Sludge from the activated method of sewage treatment is highly putrescible unless dewatered, which is an expensive operation. Success in dealing with this problem is reported by T. Chalkley Hatton of Milwaukee, but the details and cost data are not yet available. As pointed out in the Contract Record of August 9, 1916, on page 789, experiments are still under way with dewatering methods at the plant of Armour & Company, at the Chicago Stock Yards, but final conclusions have not yet been reported. It seems to them, however, that a battery of vertical-flow settling tanks, which decrease moisture to 97 per cent., followed by a Worthington or similar press, is the best method up to the present. The sludge, after pressing, is dried by a direct or an indirect-heat drier to 10 per cent. moisture, which is necessary in order that the material may be used in making fertilizer. The cost of this method is such that the commercial value of the product must be considerable in order to make the treatment available. If means of transporting the dried product to market are costly, or fail at a critical moment, serious trouble may arise.

Mr. Noble, of Armour & Company, writes that their further analyses of the sludge for the fertilizer value show it will run between 4½ and 5 units of ammonia and the value will be about $9 to $10 per ton in the dried state. Mr. Hammond indicates that these figures apply to the sludge derived from stock-yard sewage and will probably not be equalled with ordinary domestic sewage.

The Use of Screens

Mr. Hammond believes that the difficulty of minimizing the surplus sludge can be overcome to a considerable extent by means directed to the removal of sludge-producing material from sewage previous to the treatment—for instance, by screens or tanks. So far no complete data are obtainable on this point, but experiments seem to justify the expectation of success. Experiments are needed to show how fine a screen should be, for if it removes too much suspended matter the process may be seriously interfered with. The Imhoff tank, so far as Mr. Hammond's experience goes, is not likely to prove as successful as the screen in this preliminary treatment, as the tank takes out too much of the best size material in suspension for the activation process. But this is not stated as having been proved conclusively. If an Imhoff tank is used, the surplus activated sludge might be reduced to the condition of Imhoff sludge by being introduced into the digestion chamber.

While the conditions at Milwaukee are rather unique, and favorable to the activated-sludge method, as well as to the transportation of the dewatered sludge, it is doubtful, according to Mr. Hammond, if other cities less favorably situated will feel justified in going to the expense of installing extensive plants for dewatering sludge. The combination of a commercial venture with sewage disposal need not necessarily prove a failure, but the chances against its success do not make the project seem attractive.

A recent communication from Mr. Hatton, of Milwaukee, states: "After elaborate experiments on the dewatering of sludge and sludge drying we find that there is little of the problem connected therewith that has not already been solved in industrial establishments where material of like character must be treated. Either of two kinds of presses will reduce the moisture from 99 to 75 per cent., and there is no difficulty by either the direct or indirect drier to reduce this moisture from 75 to 10 per cent. or lower."

This statement is of great interest and seems very promising. It seems, however, that in most places the problem will always be how to minimize the formation of surplus sludge and how to get rid of what does form without dewatering it in a plant especially provided for this purpose. If it costs more per ton to dewater than the sludge will sell for, or the net value obtainable therefor, then even though the value figures at $9 to $10 per ton, few will care to undertake such a venture, or at least go farther than what would be the fair cost of sludge disposal by other means.

Dewatering is Difficult

Dewatering sludge is a matter of difficulty and expense and cannot but add a burden to the maintenance of a plant. This may be provided for in large plants, if the value of the sludge recovered warrants, but in small plants it would probably lead to a nuisance and would not be usually undertaken where the sewage amounts to less than 10,000,000 gallons per day.

The Schaefer-ter-Meer centrifugal sludge drier, used on a large scale at Frankfort-on-the-Main, and at Hanover, in Germany, has been thoroughly developed as a sludge-drying machine, which can handle with success large volumes of sludge and dry it sufficiently to burn readily in an incinerator plant. This machine was experimented with at the Jamaica sewage-disposal plant on Long Island, N.Y., and tests show that operating on sludge containing 91.5 per cent. of moisture, from a lime-precipitation tank, it affected a removal of 64.2 per cent. moisture, and operated continuously while effecting this removal. The cost of this method, as shown by the tests, was rather high, but the tests were really not a fair exhibition of what these machines can do, as the sludge treated was limed sludge and entered the machine in a sticky state, not favorable for economical operation.

The Dickson method of sludge dewatering, which employs brewers' yeast to effect a separation of water and sludge, also offers a possible means of success, and has the advantage of a fully developed system

by means of which the dewatering and drying can be carried from the commencement to the completion of the process, without extra handling between the various steps. The dried sludge leaves the apparatus in bags ready for shipment to the fertilizer factory, or may even be made a complete fertilizer ready for market as it leaves the plant.

So far the cost of these methods has not been determined for activated sludge, but, in the opinion of Mr. Hammond, it will be lower than the cost for drying ordinary sludge. It is quite possible that the sludge may be destroyed by a septic process where the amount of it is not great enough to make dewatering an attractive measure. But little study has been done in this direction and much is desirable,

Aeration of Sludge is Promising

As the sludge tends to break up and dissolve with over-aeration, and in doing so diminishes in volume, this gives promise of still another method that so far has received but little study. It has been found that by means of long-continued aeration activated sludge may be broken up and reduced to 10 per cent. or less of its original volume. The problem is to get rid of the water during this reduction, so as to decrease the volume to be aerated. That this may be done seems fairly possible.

Taking the surplus activated sludge as a special problem, it would seem that we should be able to design a plant to reduce its putrescible contents by means of biological agencies. If we may treat the sewage by "activation," why may we not, also, find such a means of treating the sludge? Since we have found that long-continued aeration will reduce it to a very small volume, can we not find means of doing this without excessive cost for air?

We observe that after a short aeration period with activated sludge clarification of the sewage takes place, and that out of 1,000,000 gallons we have a net amount of 2,000 to 4,000 gallons of sludge, which we must dispose of separately, and this is about 99 per cent. water. Clearly we can afford to aerate this small volume for a long time, if necessary, to effect its reduction to a form which will not cause a nuisance. Experiment shows that about half of this volume is free water which can be removed by an hour's tankage, and that 24 hours' aeration of the sludge will separate a large part of its remaining water, and the bacteria will keep on working for us. Thus we are continually treating a diminishing quantity of sludge, and the problem of design seems the principal problem.

Sewer Deposits—Their Prevention and Removal

The subject of sewer deposits sooner or later demands the attention of practically every municipal engineer, and for this reason we are reproducing below an excellent paper by Mr. Henry A. Cutler, M. Inst. C. E., city surveyor of Belfast, recently presented before the Association of Municipal Authorities of Ireland:

All who are accustomed to the design of sewers endeavor to obtain such gradients as will give self-cleansing velocities when the sewers are flowing full—that is, velocities of about three feet per second for small sewers, decreasing as the sewers increase in size to a minimum of about two feet per second, and as circular sewers have theoretically the same velocity when flowing half full as when flowing full, they will remain self-cleansing under all conditions of flow between those limits.

When the normal condition of flow is small compared with the size of a sewer (although when flowing half full it may be self-cleansing) deposits will occur. A small decrease in velocity will allow the particles which are largest and of highest specific gravity to be deposited, and a further decrease the smaller and lighter particles.

As there are many conditions to be satisfied when determining the sizes and gradients of sewers, it is not always possible to make them self-cleansing under all conditions, and, further, we do not always give the normal flow conditions sufficient consideration.

Variations of Flow.

To form some idea of the possible variations of flow, let us consider the conditions in a densely populated area, where there may be as many as 250 persons to the acre, a sewage flow of 30 gallons per head per day, and a rate of rainfall flowing off during the heaviest storms of 0.66 inch per hour. The average rate of sewage flow from such an area would be 50 cubic feet per hour, and the minimum about 25 cubic feet per hour, and the maximum rate of rainfall flowing off would be 2,420 cubic feet per hour, or about 100 times greater than the minimum sewage flow. Even taking sewers the maximum discharging capacity of which is only six times the average flow, we get a variation of 12 to 1 between the maximum and minimum, and as the Local Government Board requires that sewers should be of sufficient size to convey sewage to the outfall works for treatment at the rate of at least six times the average sewage flow, it will be seen that, without having to provide for heavy rainfall, the conditions are sufficiently difficult to deal with.

Taking the variation of 12 to 1 as the least that must be contemplated with combined drainage, and assuming that such variation is taking place in a circular sewer which is running full when discharging the maximum quantity, the depth of flow when the minimum quantity is being discharged will only be 0.19 of the diameter, and the velocity 0.59 of the velocity when flowing full or half full.

Oval or Egg-shaped Sewers.

Sewers of large capacity are usually made oval or egg-shaped, with a view to increasing the velocity where the flow is comparatively small, and applying the foregoing variation of flow to an egg-shaped sewer the minimum depth of flow would be 0.21 of the vertical diameter of the sewer, and the velocity 0.64 of the velocity when flowing full.

From these figures it will be seen that with a variation of flow of 12 to 1, gradients of sewers, so that they may be self-cleansing at all times, should be such that the velocities when running full would be from about 3½ feet per second for large sewers to about 5 feet per second for small sewers.

As in fixing the sizes, one has to provide for an in-

crease of population over a period of about thirty years, the problem gets the more difficult, and the original minimum flow, compared with the capacity of the sewer, may be such that it is absolutely impossible to prevent deposit.

Fortunately, the proportion of solids reaching sewers is much smaller during the period of minimum flow than at other times, and as they usually consist chiefly of the smaller and lighter particles, velocities less than what are usually considered self-cleansing will remove them. It is also often found that deposits which accumulate in sewers in dry periods owing to sluggishness of sewage flow will be washed out in times of heavy rainfall, but such accumulations may become offensive in warm and dry weather and require to be periodically removed.

Although in most cases in designing new sewers it is possible to make them self-cleansing, there are cases where the necessary gradient is impossible, especially where gradients are governed by the levels of existing sewers. It is also sometimes found that sewers which would have a self-cleansing gradient for ordinary sewage become sewers of deposit owing to the character of the liquid discharged into them.

Removing Deposits.

Having considered the difficulties and, under some conditions, the impossibility of preventing deposits in sewers, the question of how deposits are to be removed when they occur naturally arises. The most common, and usually most satisfactory, method is by flushing, but to be effective it must be carried out systematically and periodically.

Flushing may be carried out by specially constructed tanks with a syphonic discharge; by discharges from tank carts, or by damming the sewage flow until a large quantity of sewage is impounded above the length to be cleaned and suddenly releasing it. For flushing branch sewers or the upper ends of main sewers the permanent flushing tank or tank carts are the only possible means; but for main sewers, especially large ones, flushing by damming up the flow is usually the cheapest and most effective method.

Cases where deposits cannot be removed by flushing alone are not uncommon, as most officers who have had charge of sewers will have found, and the removal of such deposits is always expensive and sometimes impossible except by breaking into the sewer at frequent intervals. The most usual method of removing such deposits is by a chain and "badger," which is moved backwards and forwards in the sewer to rake up the deposit and keep it agitated so that it will be carried down by the flow in the sewer. Badgers are made according to fancy, the most usual being a bunch of heavy chain fixed to the hauling chain, but sometimes some form of bucket or disc is used. The hauling chain is got through the length of sewer to be cleaned by first floating a line through or pushing it through with sewer rods. Badgers are useful where there is sufficient flow to carry off the deposit when agitated, and some form of bucket or disc may be useful if there is not much deposit in the sewer, but it cannot be pulled through against any weight of silt.

A Special Apparatus.

Difficulties have recently been experienced in Belfast in cleansing a sewer where the gradient was very flat and the deposit of a plastic nature, due to the presence of tarry matter. After the usual methods of removing the silt had been resorted to without success, openings had to be made about every 20 feet, the crown of the sewer removed, and the deposit dug out. As these operations were costly, and caused permanent damage to the sewer, the author considered the matter of sufficient importance to warrant the spending of time in trying to devise special apparatus to deal with the deposit without breaking into the sewer.

After designing several forms of scraper, models were made and tried in a glass tube partly filled with sand, and ultimately a full-sized scraper was made in accordance with the model, which proved most successful. The actual scraper did its work well, but, owing to open joints in the sewer in which it was tried, it was found necessary to make some improvements to prevent the scraper sticking in the open joints. Since the improvements were made, sewers of lengths up to 100 yards between manholes have been successfully cleaned, even when more than half full of silt.

The scraper does not enter the sewer at the upper end of the section to be cleaned, but at the lower end, from which it is pulled in by a rope previously passed through the sewer, the act of pulling in causing it to lie flat and skate over the deposit; when the scraper has been pulled in a few feet (according to the quantity of deposit in the sewer), it is withdrawn by a rope attached to its after-end, the pulling back causing it to open up and bring the deposit back with it. The operation proceeds a yard or so at a time, the scraper being pulled farther into the sewer each time it is introduced, until ultimately the whole of the deposit in the section has been removed. After each withdrawal of the scraper the silt is filled into buckets and lifted to the surface, and the quantity of deposit against which the scraper has to be pulled is limited by the extra distance the scraper is drawn in after each operation.

Repairing Leaky Joints.

Where sewers are laid in running sand, and any open joints occur, sand will find its way into the sewers with the subsoil water, and if the velocity of the flow is insufficient, deposits will accumulate. The author has had some trouble of this nature, and by means of special devices has been able to remake leaking joints and execute other repairs where the sewers have been over two feet in diameter without opening from the surface.

Where the sewer is large enough clay stanks are usually constructed inside the sewer at each end of the portion under repair, and a trough put in between the stanks so as to keep the sewage from the bottom and walls of the sewer while the repairs being made. As the size of the manholes limits the length of the trough which can be got inside the sewer, short lengths are usually joined together in position.

As the space occupied by an ordinary trough prohibited its use in the small sewers the author was repairing, a length of canvas about five yards long and one yard wide was laid on the invert of the sewer and half way up the sides; the ends of the canvas were secured by iron hoops expanded inside the sewer over the canvas, and similar iron hoops were used over the canvas on each side of each joint about four inches apart. The iron hoops were served with marline so as to make a cushion against the canvas to prevent leakage past the hoops. When the canvas trough was ready, cement grout was run into the joints at the back of the canvas between the hoops and the canvas left in till the joints had set. The arrangement referred to enabled the bottom half of each joint to be perfectly made, without any obstruction to the flow in the sewer, and the top half, where the joints were not too wide, was pointed in the ordinary way.

Plastering on Concrete

Plastering on concrete is materially different from plastering on other surfaces, because concrete has little or no suction, and on this account a plaster with special requirements must be employed. The expulsion of the surplus water during crystallization and drying out, together with insufficient adhesiveness, serves to break the bond set up under the trowel. Good bond plasters are specially compounded so that the usual expulsion of surplus water during crystallization is controlled and the bond with concrete is not materially injured. They work well under the tools, have excellent spreading qualities, and are dense, durable, and fire-resisting. They maintain a practically unchanging volume during the process of setting and hardening. Although no plaster can successfully withstand the expulsion of the moisture during the drying out of concrete which occasionally brings with it an efflorescence which is deposited on the surface of the concrete, yet special bond plasters are fairly reliable in this regard.

A well-known construction company recommends the following method of attaching plaster to concrete:

Make the concrete as porous as possible by omitting sand from the mix and by not spading the concrete next to the forms. Where plaster is required underneath a floor or roof, if the forms are sprinkled with ½-inch stone before the concrete is placed, a rough surface will be obtained to which plaster will key nicely.

To attach Portland cement plaster to smooth concrete, hack the surface with a point, brush the surface thoroughly to get the dust out, wash it, and in every case make sure that the under concrete is thoroughly wet before the plaster is applied, otherwise the water will be soaked out of the plaster and the plaster will not adhere. Wash the surface with grout just ahead of the plaster and make sure that the plaster is applied before the grout has time to set.

It is the experience of this company that lime plaster is very unsatisfactory for placing on concrete surfaces. The only way they have been sure of a satisfactory result is to use plaster which is principally composed of plaster of paris.

"Skinning" Doesn't Pay

A tenement building in course of construction in New York City collapsed last August, killing two men and injuring fifteen others. An investigation showed that the failure was due to the contractors "skinning" on cement. A bricklayer testified that he overheard one of the owners of the apartment house tell another that he feared the building would fall if more cement was not used in the mixture. This "skinning on cement" is an extremely common practice and one that has contributed to the ruin of many a building (and contractor). Being stingy with cement is dangerous, and any laxity in inspection on the part of city officials only leads to this practice. Strict inspection is required if catastrophe is to be averted.

In the New Orleans Building Review Mr. C. W. J. Melville, C.E., has written an article pointing out the dangers to be encountered in constructing a concrete building with a lean mix. He shows that "skinning on cement" doesn't pay. This article follows:

In making up specifications, architects and engineers are sometimes tempted to use a leaner mix for concrete than their good judgment would indicate, with the idea that they are making a considerable saving in the ultimate cost of the work.

Some small and unreliable contractors are also in the habit of skinning the mix of concrete—that is, leaving out as much cement as they think the architect will stand for—under the impression that they are making considerable financial gain for themselves.

The following table is worked out with a view of showing that there is very little economy to the owner when the architect specifies a lean mix, and also very little financial gain to the contractor when he skins his mix without the consent of the architect even though he gets away with it:

				Saved over 1-2-4 mix.		Loss of Strength from 1-2-4 mix.	
Mix.	Cost per cubic yard, materials only.	Total cost per cu.yd., complete.	Crushing strength per sq. in.	Cents per cu. yd.	Per cent	per sq. in. Pounds	Per cent
1-3-6 ...	$4.44	$15.44	1950	.72	4.5	490	20
1-3-5 ...	4.57	15.57	2030	.59	3.6	410	17
1-2-5 ...	4.93	15.93	2200	.23	1.4	240	10
1-2-4 ...	5.16	16.16	2440	...	...	...	..

This table is based upon the average crushing strength of concrete as given by the best authorities on tests made when the concrete is thirty days old. It is based on the following prices for materials:

Cement, $1.90 per barrel net; sand, $1.35 per cubic yard; gravel, $1.80 per cubic yard. All prices are for the materials delivered at the job.

In making up the total cost for the concrete, the carpenter labor, lumber, mixing and placing, and the reinforcing steel have been assumed at $11 per cubic yard, which is a very conservative assumption when the present price of steel is taken into consideration.

The first column of this table gives the mix of the concrete; the second the cost of materials required for one cubic yard of concrete; the third column gives the total cost per cubic yard of reinforced concrete in place, including carpenter labor, lumber, labor of mixing and placing the reinforcing steel. The next column gives the average crushing strength of concrete per square inch. The next two columns show the amount in cents per cubic yard and also the percentage saved using a 1-2-4 mix as a basis. The last two columns show the loss of strength in pounds and also the percentage of loss, using a 1-2-4 mix as a basis.

By studying this table it will be observed that the difference in cost between a 1-2-4 mix and a 1-2-5 mix is only 23c per cubic yard, or 1.4 per cent., while the loss in strength is 10 per cent. It will be noticed that the amount saved between a 1-2-4 mix and a 1-3-6 mix is only 4½ per cent. of the cost of the concrete work, while the loss of strength is 20 per cent.

If we take into consideration the total cost of the entire building and assume that the concrete work is one-fifth of the total cost of the entire building, which is the usual percentage, we note that by changing the mix from 1-2-4 to 1-2-5 we save only one-third of 1 per cent. on the total cost of the building, while the strength is cut down 10 per cent.; while if we change the mix from 1-2-4 to 1-3-6 we save less than 1 per cent. on the total cost of the building, while the strength is cut down 20 per cent.

From this tabulation it is easily seen that it is poor economy to skin the mix of concrete; and the old saying that "the best reinforcement for concrete is cement" is fully verified.

The contract for reinforcing steel for the Canadian Government Railways' new elevator at St. John, N.B., has been awarded to the Burlington Steel Company, Hamilton, Ont.

Experimental Work on a Delaware Road Shows Important Results

A portion of a new trunk highway, known as the Coleman du Pont Road, has recently been completed in the State of Delaware, U. S. A. This road has afforded an opportunity to carry out many experiments on an extensive scale, and on this account the work is of special importance and interest. The early experiments, many of them four years old, dealt with the use of various kinds of asphalts or tars with different aggregates. Later experiments comprised tests on concrete pavement and included such problems as the effect of hydrated lime on concrete; the most economical length of slab; the various kinds of reinforcement; the different kinds of surface finish; methods of curing; the results of using different sands; the advantage of thoroughly mixing the ingredients; the types of joints, etc.

The results of these tests should prove interesting to Canadian municipalities that are projecting this type of highway, and there are more and more of such roads being built in this country each year. Special information was developed concerning the cracks that are the troublesome features of concrete pavements, and which often prejudice people against the use of roads of this type.

Reinforced concrete forms the greater portion of the completed work on the du Pont Road. The pavement measures 14 feet in width, 7 inches deep in the centre and 5 inches deep at the sides, and is laid on a flat subgrade. Reinforcement is generally used. The mix used was 1:2:4 with different quantities of hydrated lime up to 10 per cent. by volume.

Thorough Mixing

Experiments carried out to develop the advantage of thoroughly intermingling the ingredients showed that the strength of concrete was greatly increased by thorough mixing. It was considered, however, most economical to mix for 1½ minutes, although the tests developed that there was an increase in strength by mixing up to four minutes.

The Length of Slab

The length of slab to be used was a seemingly important problem, for it appeared that the number and extent of cracks depended largely on this feature. Roads already built showed slabs varying in length from 25 feet to 60 or 70 feet, and in many instances cracks were almost as numerous in short slabs as they were in long ones. The question of the ultimate limit to the length of a slab was naturally raised. If a 70-foot slab could be satisfactorily constructed without its length being a detriment, why should the length not be increased to, say, 100 or 200 feet. Experiments were conducted with a view to getting ideas on this point and to find where cracks would occur. Joints were placed only when the concrete mixers stopped for more than 15 minutes, with the result that some very long slabs were produced, some reaching 500 feet long. It has been found that so far the slabs have remained intact, with the exception of a few transverse cracks which, although not a serious injury to the road, are rather unsightly. The cracks generally appeared in the longest slabs, their regularity seeming to indicate a definite principle of contraction. By studying this experimental data, it was found what was the longest slab, without cracks, that could be used under the particular conditions that applied to this road. Shorter slabs were employed for the purpose of getting away from these cracks, but although this was accomplished, the increased number of joints created a more serious condition.

The Value of Hydrated Lime

Experiments were performed to prove the efficacy of hydrated lime. Laboratory tests showed that this material strengthened the concrete made from some sands, but weakened that made from others. In the field, hydrated lime was observed to reduce the number of transverse cracks, as the amount was increased up to ten per cent. It seems to make the concrete flow more freely and prevents segregation of the coarse aggregate and is thus of assistance despite the slight increase or decrease of strength that may be occasioned. The greater number of cracks develop during the first 24 or 48 hours, and hydrated lime causes the concrete to retain the moisture longer and decreases the contraction during the period when the concrete is acquiring strength, which assists the prevention of transverse cracks.

During the early spring, when the concrete was saturated and expanded, and when the expansion was at its maximum due to the temperature, a number of the slabs rose at the joints, in some cases as much as 1¼ inches, causing an abrupt unevenness. Nearly all of the slabs returned to their normal position after complete drying. At the cracks this uneven condition was not observed and consequently it was decided to eliminate any chance of movement at the joints and maintain the cracks. On this account the slabs were not restricted, but made as long as possible.

Reinforcement in Relation to Cracks

The value of reinforcement in preventing cracks was open to question. Experiments were conducted along this line, although more study is yet required to provide conclusive results. Reinforcement does not prevent cracks, but in the smaller slabs it has a tendency to prevent the cracks from opening, although in long slabs the cracks will open in spite of the metal, especially in the autumn, after a dry spell, and when the temperature suddenly drops.

In making the joints of this road metal protection plates were generally employed to protect the edge from abrasion when there was any unevenness. Some butt joints were used with no protection plates. In some cases this type of joint was reinforced with steel rods across the joint, giving it the appearance of a fine crack. This process resulted in a slab 1,240 feet long.

The finishing of the surface was especially conducted to secure smoothness. A power template was used on one section and a very satisfactory surface obtained. On other portions, a steel template made of angle iron was employed with hand floating after, but the resulting surface was irregular and somewhat unsatisfactory. A second template kept several feet in the rear of the first and consisting of a float 14 ins. wide, shaped to the crown of the pavement, remedied the irregularities and produced a smooth surface.

The curing of the road was carried out by protecting with a canvas cover until the concrete was sufficiently hard to hold a covering of earth, which was kept soaked for fourteen days. After thirty days this was removed and a few days hardening in the air allowed.

All materials were carefully inspected and tested by the State Bureau of Inspection to ensure satisfactory ingredients.

A Sulphite Plant for a Merritton Paper Mill

The Purdy & Henderson Company, Ltd., New Birks Building, Montreal, have obtained a contract for the construction of a sulphite plant for the Lincoln Paper Mills Company, Merritton, Ont., from plans prepared by G. D. Jensson & Co., New York. The plant comprises a number of buildings—digester, blow pit, wet room, and acid room buildings and acid towers. The digester and blow pit buildings are to consist of steel frames, with brick exteriors and tile roofs; the wet room building is to be of brick, with steel girders in the roof and tile roof construction; the acid plant and acid towers will be constructed of reinforced concrete. The digester building and acid towers will be each 100 feet high, and the other buildings will be one-storey structures.

Mr. Mawson Discusses Soldiers' Aid

Mr. Thomas H. Mawson, of Liverpool University, the well-known authority on town planning, recently paid a visit to the city of Toronto, and then left for Ottawa, to confer with Sir James Lougheed on the soldiers' aid question and interchange views on what can best be done to help the partially and totally disabled men to live more happy and useful lives. Mr. Mawson has written a book, in which he discusses the formation of model villages for those who have been rendered physically unfit for their former occupations, and urges that these men be given some distinctive employment, such as making pencils or toys, with assistance from the government, until they become self-supporting. He also draws attention to the possibilities in the growing of bulbs and nursery stock. Mr. Mawson is on a lecturing tour at the present time, visiting the various United States universities.

Messrs. Quinlan, Anglin, and Sommerville have been appointed by the directors of the Montreal Builders' Exchange to work out the details of a plan for the exchange of surplus plant, on a rental basis, between general contractors. This plan was outlined in our issue of October 25. The secretary will keep a register of the machinery, and will put the various contractors in touch with one another in the event of any plant being required.

The Montreal Builders' Exchange will ask the Government to open tenders for Government work in the presence of those who tendered, and to return immediately the cheques of the unsuccessful tenderers.

Mainly Constructional

East and West—From Coast to Coast

The Brockville Homes Building Company, Limited, has been incorporated with a capital of $40,000.

The Engineering Society of the University of Toronto recently held a reception to welcome home School men who have returned from the front.

It has been proposed to heat the new Parliament Buildings at Ottawa with electricity, and the architects have been asked to report upon the estimated cost of an electric heating plant for the entire house.

During the month of October, 16 building permits were issued in Kitchener, Ont., totalling $61,515. There have been 143 permits issued during the 10 months of this year, valued at $303,303.

It is now said that the Ontario Government is going to abandon the scheme of appointing a board of trustees to look after the construction of the Ottawa-Prescott highway. The alternative suggested is a government commission.

It is understood that the International Nickel Company is getting under way with its nickel refinery project at Port Colborne, Ont., for which $5,000,000 is said to have been set aside.

A new quarry of excellent red granite was recently opened by the Bay of Fundy Company, on their land in New Brunswick in the canal district. The stone is a dark red color, takes a beautiful polish, and is said to be equal to the granite that made St. George famous in former years.

Building permits issued at Welland, Ont., during the month of October totalled $16,927, and for the ten months of the year totalled $176,050. These figures compare with $524 and $139,133, which were the totals for the corresponding periods last year.

In the month of October the value of the building permits issued in the city of Toronto was $496,153, as compared with $413,756 in October last year. For the ten months of the year, January to October, the total was $5,502,802, an increase of $347,171 over the figures for the corresponding period in 1915.

At the recent board meeting of the Nova Scotia Steel & Coal Company, held in Montreal, Col. Cantley, the president, stated that the firm's output for the first nine months of 1916 was 40 per cent. higher than the previous year. As regards forward business he said the company was booked practically to capacity to the middle of 1917

A special meeting of the city council of Chatham, Ont., is to be held at an early date to consider a building by-law which has been given its first and second readings, having been held in abeyance from last year. The city engineer is to be present at this discussion, and members of the Builders' Exchange will also be notified regarding it.

During the month of October, 1916, there were 171 building permits issued in the city of Montreal, the total value being $352,925, as compared with 214 permits in the same month last year, at a value of $493,268. The year's permits up to October 21st number 1,669, and are valued at $4,139,934. This compares with 1,832 permits in the same period last year at a value of $5,005,526.

The old Boulder hotel building at the northwest corner of Carroll and Cordova streets, Vancouver—the pride of the city years ago owing to its stone construction—is being remodelled for modern banking purposes and will be occupied by the Royal Bank of Canada, which acquired the block about three years ago. The work is being done by Messrs. Purdy & Henderson, contractors, at a cost of $10,000.

The Nova Scotia Steel & Coal Company decided at their recent meeting to build another ocean-going vessel, about five per cent. larger than the one now under construction. Good progress has been made with the latter vessel, the frames being all up and the double bottom practically placed. It should be ready for launching in the spring.

The building permits issued in London, Ont., during the month of October this year number 118, and are valued at $110,145, as compared with 129 permits in the same month last year, value $110,980. There were 939 permits issued in 1916 up to October 31, their value being $842,570, while during the corresponding period last year 1,142 permits were issued, value $1,107,890.

Plans are now being prepared by the Northern Pacific Railway for new freight terminal buildings at New Westminster. Two years ago the company leased part of the new market site, paying over $50,000 in advance rentals, and

the decision to proceed with the improvements is taken as an indication that a period of big business is now in sight. A steel building will likely be erected, together with large warehouses for freight.

Work on the new Pantages Theatre at Vancouver, to cost about $300,000, is being pushed with all possible speed by the contractors, Messrs. Skene & Christie, who built the new Hotel Vancouver at a cost of over $2,000,000. The pouring of the cement foundations is now in progress and steel and other material for the superstructure is being assembled. The walls will be up and the roof on before Christmas.

Seven or eight hundred men are now engaged in work on the Dominion Parliament Buildings. On the east wing of the Senate Chamber most progress has been made, the walls having been built up to within a few feet of the top of the first storey. It is expected to have the masonry of the walls in place as high as the sills over the whole building before winter sets in. The basement has been roofed over with a solid sheet of 9-in. concrete, heavily reinforced.

J. A. Kinney, of Edmonton, an organizer for the carpenters' unions in the west, recently returning from an extended trip through Manitoba, Saskatchewan and Alberta, states that labor conditions, especially in the carpenter trade, are in very good shape indeed, the demand being far in excess of the supply. This is partly due to the large percentage of carpenters who have gone to the war and partly to a renewed action in the building trade.

In the New Glasgow works of the Eastern Car Company —a subsidiary of the Nova Scotia Steel & Coal Company— a drop forgings plant and an electric furnace are being installed, in accordance with a recent decision of the directorate. These will make the works self-contained in practically every respect, and will obviate delays. In addition to some foreign business, the company is busy on an order for 500 fifty-ton cars for the Transcontinental Railway, which is to be finished by the end of the year. The cars call for a capacity of 3,265 cubic feet.

Messrs. R. J. Wig, of the Bureau of Statistics of the United States Government, and R. L. Ferguson, chief engineer of the Association of U. S. Cement Manufacturers, spent a few days in Victoria recently. The former, who is inspecting seawalls of recent construction, made a close examination of the Dallas Road and Ross Bay works, while the latter gave his attention more particularly to the use of cement in road construction. Naturally the Victoria authorities feel flattered at this proof that their municipal works have been so constructed as to offer valuable data to the United States Government and the cement industry.

A verdict was recently rendered at Napanee, Ont., awarding $175 damages to the owner of a horse, the owner claiming that the animal had died as a result of over-exertion in endeavoring to haul a load of milk over the boundary road, due to the poor condition of the highway. The judge commented on the penny-wise and pound-foolish policy of municipalities in not keeping their roads in proper repair, and further intimated that it might be a proper case for preferring an indictment against the corporations for their persistent neglect to perform their duty with respect to roads.

It had been estimated that the 20 counties under the Ontario Highways Act would spend approximately $750,000 on highway construction this season, but it is doubtful if this expenditure will exceed $700,000. Labor difficulties and other matters are responsible for this. There will be an appreciable rise in maintenance outlays, however. Government assistance in maintaining roads afforded an impetus in this direction, the counties' programme involving about $220,000. Leaving out of account the Toronto-Hamilton highway, the road expenditure in the province will be about $950,000, of which the Government will contribute around $330,000.

It appears that the London press is favorable to the English Channel tunnel project and that Premier Asquith, who recently received a deputation regarding it, is also in sympathy with the idea. Late in August it was announced in Paris that France had taken all the necessary steps to enter into negotiations with England for the joint construction of the tunnel. Plans were outlined by M. Sartiaux, chief engineer of the Nord Railway Company, who stated that the tunnel would cost £16,000,000. It is stated that the English Tunnel Company, which controls the right to construct tubes, is becoming active, and that the capital is subscribed and the initial boring well under way.

Plans and specifications have been prepared for a hydro sub-station to be erected on York Street, Stratford, Ont., by the Public Utilities Board. The new building is to be constructed on the site of the old brick boiler room, but the old wall on the south side will be retained. The structure will be 30 feet wide, 64 feet long and 42 feet high, with two storeys, and a basement under the entire building. The foundation wall will be of concrete and the superstructure of red brick and stone, while the girders will be of regular structural steel. The walls facing the street will be of the ornamental style with cut iron. The building throughout will be fireproof, the roof and girders being protected with concrete.

Personals

Mr. W. H. Baltzell has been appointed chief engineer of the Canadian Steel Corporation, Limited, with offices at Ojibway, Ont.

Mr. W. W. Brookfield, of Welland, Ont., has been appointed good roads superintendent of Welland County, to succeed the late Major James Sheppard.

Mr. F. L. Fellowes, city engineer of Vancouver, attended a meeting of the executive of the Union of B. C. Municipalities, held at Vernon on October 10th, and delivered an address at the annual convention held on the two succeeding days.

Capt. W. J. Loudon, who was formerly employed by the C. P. R. as engineer supervising railroad construction work, has been wounded, but word has been received by his father to the effect that he is progressing favorably.

Mr. R. F. Randolph, who has been in the employ of the Bethlehem Steel Company, has been engaged by the Dominion Steel Corporation, Limited, Sydney, N.S., as general superintendent of all steel work.

Mr. E. P. Mathewson has been appointed general manager for the British America Nickel Corporation of Sudbury, Ont., with headquarters at Toronto, having resigned his position as manager of the reduction works of the Anaconda Copper Company.

Mr. C. A. Amirault, who for 25 years has been connected with the engineering department of the city of Montreal and is at the present time engineer of the sidewalks and sewers division in the office of the chairman of the Board of Assessors, will shortly resign. Mr. Amirault is one of the oldest engineers in the civic employ. For many years he was chief engineer in charge of the northern division of sewer work.

Obituary

Lieut. Carl J. Beatty, of the Royal Flying Corps of the British Army, was recently killed in action. Lieut. Beatty had been in the employ of the engineering department of the British Columbia Provincial Government for some time before he enlisted. Previous to that time he had been a member of the engineer corps of the Northern Pacific Railway.

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The Question of Tenders and the Rights of Tenderers

THE methods generally adopted in the calling of tenders and the awarding of contracts is, at best, a phase of our business life that is open to discussion, though opinions may differ as to the best remedy for the defects. There can be no difference of opinion as to the existing facts, however, viz., that there is something in current methods—particularly in municipal work—that smacks of the unsavory, and a great deal that is obviously unjust. Competitive bidding, involving as it does a large expenditure of labor and time on the part of those tendering, is a game that should be played fair. Tendering is largely speculative and, as such, can never be quite above suspicion, but any recognition of this on the part of authorities—any latitude which admits of a possibility of tampering with bids after they have been sent in—should be strictly tabooed. The game should not be made a gamble, with dishonesty thrown in. It is true some bids are submitted in the hope that a chance stroke will cause their acceptance, but responsible bidders submit their tenders intelligently and trust that the fairness of honest competition will be instrumental in determining acceptance or rejection. It is only fair to those bidding, then, that no unsavory procedure should be allowed, and, indeed, that there should be no opening for suspicion. It is an outrage upon those who play the game in good faith to permit any action that is not above suspicion or to leave an opening for the intrusion of the irresponsible bidder or the grafter.

* * *

In last week's Contract Record an item was published intimating that the Montreal Builders' Exchange will ask the government to open tenders for government work in the presence of those who tendered and to return immediately the cheques of unsuccessful tenderers. We heartily endorse such action, but why limit it to government work? Why not make it just as applicable to municipal interests? It is in such connection that a great deal of the dishonest and suspicious conduct of contracts occurs. The item referred to brings out one great defect in connection with municipal tenders. Perhaps nothing is calculated to cause distrust so much as the common and pernicious habit of opening tenders secretly. But, though this practice is widespread, this does not constitute an excuse, nor does it minimize to any degree its perniciousness. It pays to be frank, and any attempt at temporizing only leads to suspicion. Such practice is to be condemned, not only on high moral grounds, but also on the grounds of fair play and square treatment. Bidders who submit their offers gratuitously are entitled by the highest ethics of business to be present when the contract is awarded.

The remedy that naturally suggests itself is to make it a general law that tenders must be opened at the hour the bidding ceases. The tendency to delay the award is disconcerting and unfair to the bidder. Delay means in most cases loss of money and time. Delay gives rise to suspicion which, in many cases, has been well-founded. An opportunity is offered for unscrupulous or irresponsible bidders to submit bids or tamper with those already in.

* * *

Then, again, if an hour is set it should be observed. We recently heard that in one Canadian municipality three United States representatives travelled north to be present at the opening, at the appointed hour, of tenders for work on which their firms had bid. The mayor delayed the matter for a week on a purely trivial pretext, and calmly informed the bidders to call again. An action of this kind is bound to be harmful to the best interests of the city, inasmuch as it will tend to keep honest, reputable contractors out of the running.

The obligation of returning cheques of unsuccessful tenderers promptly, also, too frequently goes unrecognized. Indeed, the practice of retaining them is very widespread. We occasionally hear of municipalities financing their contracts on retained deposits, keeping those accruing from one contract until the funds similarly derived from the next work should enable them to pay off the first debt. Such cases may be supernormal, but they simply indicate the extreme to which a bad practice may be carried. Municipalities will gain in the end if tender procedure is played

fair. Nothing can be more harmful than secret awarding of contracts, and the surest remedy is to open the tenders at the time of closing and return the cheques of the unsuccessful bidders promptly.

The Advantages of Co-Partnership Between Engineers and Architects

A PARTNERSHIP between a structural engineer and an architect often proves an ideal union of the economist and the artist, states a writer in Engineering and Contracting. Recently the personal columns of civil engineering journals have recorded an increasing number of such partnerships. We venture the prediction that each coming year will witness a marked increase in engineering-architectural co-partnerships.

There are many new forces at work that tend to develop relationships of this sort. To begin with, the increasing wealth of the country leads inevitably toward the construction of larger and better buildings of all sorts. The financial progress of every nation is always marked by the betterment of both residential and industrial buildings. With larger investments in buildings there comes greater care in selecting the designers. And when an owner gives careful thought to this matter, it takes no unusual powers of perception to recognize that it pays to employ a designer skilled in study of building economics—structural engineering.

Educational publicity is playing an important part in convincing owners that it pays to build for permanence. When to the publicity effected by manufacturers of cement, tile, steel, etc., there shall be added the publicity that individual engineers and structural engineering societies can effect, owners will more commonly demand engineering services of high order in the designing of buildings. We believe that this demand will not relate to industrial buildings only, but will involve residential buildings. Take, for example, the problem of heating a house. Here is an engineering problem of no mean intricacy, yet, as conditions now exist, its solution is usually left to the mechanic who installs the heating apparatus. How many house owners know that the efficiency of the average furnace is less than 50 per cent. and that it could be raised to 75 per cent.? How many know that the heat lost through the window glass constitutes the greatest drain upon their coal bin, and that double glazing cuts this drain in two? How many know that cheap and defective plumbing not only doubles their annual maintenance costs, but results in a vast waste of water which, directly or indirectly, they must pay for? How many know that, for equal illumination, light-colored interior walls decrease the monthly lighting bills as compared with dark walls? How many realize that white exterior walls in courts and where buildings are close together will eliminate at least one hour of artificial illumination daily? How many know that by building large refrigerators as part of the house they can not only cut ice bills in two, but reduce the cost of all perishable foods by buying in larger quantities?

We have touched but a few of many economies of household operation that are effected by the design of the house, yet they alone would justify employing an engineer in the design of every modern residence.

We believe that an engineer who specializes in household economics both of operation and construction has a better chance of winning clients than has an architect. Together a good structural engineer and a good architect should easily forge ahead of any firm composed only of architects.

Toronto's Mechanical Filtration Plant, the Biggest in the World

THE regular monthly meeting of the Toronto branch of the Canadian Society of Civil Engineers was held on Thursday evening, Nov. 9. The feature was an address by Mr. Storrie, chief engineer of the John ver Mehr Engineering Company, the designers of and consulting and supervising engineers for Toronto's new mechanical filtration plant. Mr. Storrie's remarks covered very comprehensively the design and construction features of the new drifting sand installation on Toronto Island, the largest plant of its type in the world. In introducing his subject, the speaker directed attention to the differences between the slow sand method of filtration and the mechanical (rapid) sand system. Generally speaking, they typify English and American methods. He pointed out how the general differences in the sources of supply in the two countries made the names especially applicable. The events leading up to the invention of the type of unit just installed in Toronto, known as the drifting sand filter, were described. By means of a large number of slides, also, the speaker elucidated the principles that underlie the operation of the drifting sand units—this drifting sand feature constituting the distinguishing and essential difference between this type of unit and the conventional type of mechanical filter. The slides also depicted features of construction in connection with the erection of the plant, which indicated the wonderful ingenuity exercised and care taken in securing the perfection of every detail.

Theory of Drifting Sand Filter.

Mr. Gore, the inventor of the drifting sand type of filter, was present, and addressed the meeting briefly on his theory of the basic operations of this type of filter. Mr. Gore does not consider, either that the original theory of mere screening or the later theory of removal of impurities through biological action are sufficient to explain the operations which go on in this type of filter. In Mr. Gore's opinion, purifying action is due to adsorption, by which is meant, in this instance, the mutual combining action between ions carrying electrostatic charges of opposite polarities. To be more specific, this theory is that the alum which, in solution (according to the now generally accepted theory of solution), breaks up into electrically charged ions, thus provides nuclei around which bacteria carrying opposite electrostatic charges gather. These groups of ions, having now an appreciable size, are carried off, chiefly by the drifting sand and liberated to the discharge sewer at the bottom of the filter. Such of these groups as make their way through the drifting sand and finally reach the surface of the inner fixed cone are caught at the surface, being now larger than the interstices through which the bacteria formerly passed.

Mr. Gore related that his attention was first drawn to this idea by the action of a large iron pipe supplying the city of Liverpool, in which a scum of peaty material had been deposited to a considerable thickness, and where examination showed that the water was being slowly but surely purified by adsorption as it passed along the pipe. The only difference between this pipe and the drifting sand filter is that in the first case the adsorber was a fixed body, whereas in the latter case it is a body in motion. Interesting contributions to the discussion were offered by Mr. R. O. Wynne-Roberts, Professor Haultain, Chairman McCarthy, and others.

Port Arthur, Ont., Water Supply System

Modern and Efficient Methods Used in Constructing the New Plant — Description of Buildings and Equipment

THE new water system of the city of Port Arthur, Ont., draws its supply from Lake Superior through an intake pipe located 2,350 feet from shore. This source after examination of all other possible plans seemed to possess the most favorable advantages so far as the quality and clearness of the water were concerned. In designing the system the aim was to acquire, as far as possible, (a) a pure supply of water; (b) a continuous service; (c) maximum efficiency in pumping plant, and (d) efficient domestic and fire service. The first was secured by having a supply from Lake Superior, which is good, provided that chance pollution may be counteracted by disinfection, filtration not being required at present. A continuous service was assured by reasonable duplication of plant, pipe line and intake. The matter of plant efficiency is subject to good design, installation, choice of pumps, etc., while efficient service can be maintained only by a combination of the previous factors, together with watchfulness and foresight in operation.

The plant is designed to supply sixteen million gallons per twenty-four hours when the duplicate lines are working in parallel. The system consists of two intake pipes delivering to a pump-house well on shore, from which the water is pumped and distributed. A chlorinating plant supplying liquid chlorine is the method of disinfection. The pumping equipment is electrically driven. The total cost of the work was $596,501.43.

These facts regarding Port Arthur's water supply are gleaned from a paper read by Mr. L. M. Jones, city engineer of that city, before the Canadian Society of Civil Engineers. Extracts from this paper dealing with certain specific phases of the work of construction are reprinted below:

Intake Pipes

The intake consists of duplicate pipes twenty-four inches in diameter extending from the pump-house well for a distance of 2,350 feet into the lake, the minimum depth of the top of pipes being 28 feet from low water level, thus allowing for dredging a harbor of 25-foot draught. At the outer end is a rock-filled crib supported on piles, through which the pipes pass vertically for a distance of fourteen feet, and on this crib and over the inlets are placed screens of ¾-inch copper mesh. To take care of any possible settlement, flexible joints were placed at the base of the crib and sufficient clearance allowed for this between pipes and screen collars. Valves were placed near the flexibles for closing off supply. The depth of water at the crib is 47 feet. For a distance of 510.5 feet from the well the pipes pass through a rock tunnel, the remainder of the pipe lines being supported on piles, with flexible joints at changes of grades.

The plans for the intake showed two alternative methods of construction; one being for excavation in open cut and the other for a tunnel through the rock at the shore end. Bids were on the basis of a lump sum for the work included between the well and crib, and showed that the tunnel scheme was to be preferred, the price being $10,000 less than for open cut, and a further reduction was made by allowing the contractor to use the well as a portion of the tunnel shaft.

Tunnelling Operations

Work was commenced on the tunnel on October 1st, 1913, and completed February 19th, 1914. The shaft below the well bottom was twelve feet in diameter, and it was the original intention to drive the tunnel 540 feet from this point, but water troubles made it necessary to cease tunnelling 5105 feet from the shaft. The first 348 feet were advanced under free air conditions and in the remaining portion an air pressure of approximately twelve pounds per square inch was applied. When the tunnelling operations ceased the two lines of pipe were laid at a point twenty feet back from the end to the well. On the outer ends of the pipes, water-tight covers were bolted, and about five or six feet back from the tunnel heading, a strong wooden bulkhead was constructed to withstand considerable shock from the submarine drilling and blasting when the end of the tunnel was blown off, while the space between the bulkhead and heading was filled with hay, brush and bags of sawdust. At a point two feet nearer the shore than the ends of the pipes a solid concrete bulkhead, four feet in thickness, was constructed, in order that the tunnel could be pumped out in the future and as a safeguard against the possibility of the blasting operations breaking down the temporary wooden bulkhead.

The character of the rock encountered was fine grain basalt, with numerous pockets or deposits of black or gray flint, which made drilling extremely slow. The mucking was done by ordinary methods of tracks and cars, the car being hoisted to the surface by derricks. There were 996 cubic yards of rock removed, entailing 11,304 feet of drilling and about 7,000 lbs. of 70 per cent. gelignite. There were 209 working shifts, the average advance per shift being 2.44 feet. The length of the air lock was thirty-eight feet between bulkheads.

Dredging

Outwards from the tunnel for about 300 feet the rock was removed by submarine drilling and dredging with a rock-digging dipper dredge. The junction between tunnel and open cut was made satisfactorily and most of the material in the temporary bulkhead floated to the surface, the remainder being removed by a diver.

From the end of the rock for a distance of 1,200 feet the material encountered was very soft and was removed by hydraulic dredging to the extent of 36,000 cubic yards. In the estimates an amount of 24,000 cubic yards was allowed, but the nature of the material made it necessary to dredge a trench 70 to 100 feet wide at the bottom, so that shoaling in of the banks would not fill the cut.

Pile Supports for Pipe Line

Originally it was intended that the pipes should rest on the lake bottom and the bed of the excavated trench, but dredging operations showed that the material was too soft and it was decided to place pile sup-

ports under the pipes. The piles were arranged in bents of two piles each and spaced alternatively 27 and 33 feet, so that one pair of pipes rested on two supports. The next pair were supported from the two pipes at either end, resting on the bents. It was thought that this manner of spacing would produce the minimum bending moments in the pipes. The piles were driven with an ordinary pile driver, drop hammer type, which was moved along the ice. Prior to driving, a shoulder was cut on the pile to receive the support, and the piles were driven to an exact grade at a depth of from 32 to 46 feet below water level by using a chaser 52 feet long fitted with a steel socket and locking device at the lower end. This socket had a diameter of nine inches and the shoulder mentioned above was cut to fit the socket. Such were the pains taken in connection with the pile driving, that the grade for the supports was almost perfect, there being only slight variations and these were either cut down or shimmed up as the case required. The supports were 3 in. x 12 in. x 10 ft., set with a measuring rod and level, and spiked to the piles. After the pipes were placed, wedges, properly cut, were spiked on the supports tight up to the pipes. Across the top of the pipes and spiked to the ends of piles projecting above the pipes, was a cap 3 in. x 6 in. x 10 ft., thus preventing any movement. The supports were placed by divers.

The piles for the crib were driven in like manner as described above, the crib itself being built above the ice and then lowered into place by block and tackle supported by bents at the four corners. Rock was placed in the crib as it was lowered and completely filled by chute from the surface.

Laying the Pipe

When the piles were being driven for supporting the pipes, a number of piles were driven to be used in lowering them. These were driven in bents of two and capped with 10 in. x 12 in. timbers about ten feet above the ice level. The bents were sixty feet apart, properly braced, and the pipes were supported from them in a continuous line by means of three-sheave, twelve-inch wood blocks, reaved up with 1½-inch manilla rope, while a wire cable passed around the pipes and through the hook in the block. At the wire cable a wooden spacer was placed between the pipes and wooden collars were placed outside, connected with ¾-inch bolts, thus preventing the pipes from separating or having any side motion. The total length of pipes lowered in this way was about 1,290 feet, in duplicate, and were lowered in two sections of about 660 and 630 feet each. In the lowering a man was stationed at each bent and a graduated rod was attached to the pipes, the pipes being lowered twelve inches at a time until they rested on the supports below. The connections were made under water by a diver, with no more than the usual amount of difficulty attending such operations.

On account of the delay in making the rock excavation, the balance of the pipe was laid from scows in open water, there being ninety feet of pipe lowered at one time. At the point of connection between the pipes in the tunnel and lake an expansion joint was provided to slide over the ends, this being properly bolted up.

The Pumphouse Well

The well is located near the shore about fifty feet from the pumphouse, it being twenty-five feet in diameter, and twenty-five feet to the bottom, from the covering slab. The first seven feet was in earth, the balance in rock, and as has been previously stated, the well formed part of the shaft to the tunnel, this portion being filled with concrete at the contractor's expense. The lining is twelve inches in thickness, while the cover is a seven-inch slab supported in the centre by a concrete pillar.

There are two operating methods for delivering water to the pumps, the usual condition being that the two pipes discharge into the well from which the water passes through a duplicate set of copper screens to the suction pipes. Should it be necessary to by-pass the well, by closing a pair of valves and opening another pair, the pumps receive water direct from the lake, these valves being operated from the cover over the well. At the inlets from the lake, sump pits are located, the bottom of the well being graded to these, which in turn are connected to the sump pumps inside the basement of the pumphouse, thus providing for draining the well. Inside the well a water connection is returned with hose connection for cleaning out well and screens. Constructed over the well is a brick building, one storey in height, in which the chlorinating plant is located.

Tunnel from Well to Pumphouse

As the connection between the well and pumphouse was deep and through solid rock, it was decided to construct a tunnel in which to place the thirty-inch suction pipes, and this also allowed the ground surface to be used in constructing the pumphouse, as on account of delays in receiving the pipe a trench would have to be left open for some considerable time.

Pumphouse

The pumphouse is a fireproof structure 31½ x 54 feet inside dimensions, sufficient to house the present equipment. On top of the concrete roof slab, a false timber roof was constructed, covered with felt and gravel, to prevent sweating and dripping. There are practically three floor levels. On the lower floor are the large pipes, sump pumps, heating plant and coal bin. The next is the main floor, having the three pumping units and the water recording apparatus; while above this floor, but not extending the full width of the building, is a gallery on which is located the switchboard, bus structure and motor generator sets. Spanning the building is a crane of eight tons capacity.

In order to secure the most efficient suction lift, when in the future the full head of the intake pipes was being utilized, it was decided to set the centre line of the pumps at lake level. This meant deep excavations, water-tight walls and first-class piping equipment.

In the walls of the basement "Ceresit" waterproofing compound was used in proportions of one-half pound to one cubic foot of concrete, the concrete being one part Portland cement to four parts lake shore gravel. When the water was allowed to rise to normal or lake level, there were slight signs of leakage in a few places, but gradually these have taken up until now all these signs have disappeared.

The three main pumping units (Escher Wyss manufacture) are centrifugal, two-stage, single-suction pumps, having a twelve-inch suction branch and a twelve-inch delivery branch, the horizontal lines of these branches being at the same elevation. They are designed for 2,000 imperial gallons per minute when pumping against a head of 300 feet, the speed being 1,200 r.p.m., and a guaranteed efficiency of 76 per cent. with a 2 per cent. margin. The impellers, guide ap-

paratus and all parts coming in contact with the water are special bronze, a nickel steel shaft covered with bronze, self-lubricating bearings of the ring type and a patent balancing device for eliminating axial thrust. There is no necessity to disconnect piping to gain access to the internal parts. The pumps will operate in parallel or in series, as may be desired, and when working in series will deliver the capacity of one pump at twice the head, or a pressure equal to a head of 600 feet can be obtained if necessary, or a range between 300 and 600 feet is available by throttling. They will discharge their rated capacity with a suction lift between 19 and 20 feet and the power required for the stated condition is 244 b.h.p. The motors are Siemens type. The booster pump was supplied by W. F. Allen & Sons.

Motors and Equipment

The motors of these units are of the self-starting synchronous type, direct connected to the pump shaft, have a power output of 275 h.p. and are capable of sustaining a 25 per cent. overload for a period of two hours without the temperature exceeding 55 degs. Cent. This overload period was considered sufficient as it was not possible to secure a 25 per cent. overload from the pumps. The guaranteed efficiency of the motors at full load was 92 per cent.

Electrical current is supplied from the Current River Station and the Hydro-electric Station. The line between the former and the pumphouse transmits power at 2,200 volts and the latter at 25,000 volts to a sub-station adjoining the pumphouse, where it is stepped down to 2,200 volts, at which voltage it is supplied to the motors.

On the gallery the switchboard and apparatus is located, there being a panel for each motor, exciter motors, exciters, power line from Current River and the transformers, while alongside the board is the panel for controlling the 25,000 volt line. At the rear of the board the switch and bus compartments are constructed of concrete slabs, there being duplicate sets of bus bars.

When changing from one source of power to the other, the 400 kv.a. transformers are paralleled with the Current River line, thus enabling the load to be changed from one power source to the other without interruption to the service.

In the transformer station is located a bank of three 400 kv.a. transformers with one spare, making four in all. They are "star" connected on the high tension side and "delta" in the low tension side, being oil and water cooled, and are mounted on castors, making their removal quite easy. The switching apparatus is placed on a floor above the transformer, all switches being located in cells made of concrete slabs.

Piping

The large suction and discharge pipes are steel with a wall thickness of 7/16 of an inch, while all other pipes, specials and branches, are cast iron. The connections are flanged and the valves are equipped with bevel gears so that they can be easily operated by one man. At the well end of the force mains six-inch relief valves are installed with a discharge pipe returned to the wall. These valves are automatic and are fitted with hydraulic regulating devices. A feature worthy of special mention is the ring pipe surrounding the units. This acts as a suction and discharge pipe and is used in pumping in series.

The Forcemain

After due consideration it was decided that steel pipe be used with cast-iron specials for the mains. The twenty-four inch pipe is of 5/16-inch shell thickness and 25 feet long, the twelve-inch 3/16-inch and 20 feet long, each tube being subjected to a test pressure of 500 pounds per square inch. All joints were bell and spigot. The outside surface of the pipes were protected by a wrapping of burlap, and the whole dipped in Dr. Angus Smith's solution.

Disinfection by Chlorine

Liquid chlorine is used for disinfection. The plant requires a space of only 7½ feet by 8 feet, yet is capable of treating the water supply for years to come. The efficiency of this plant cannot be fully determined yet.

Business Methods Applied to Road Upkeep

By Mr. W. P. Blair*

THE whole problem of streets should be managed in the same way as is any modern business having as its ultimate object progress or profit. There is no objection to the careful watching of all expenditures by the means provided in various published methods of cost accounting. But it is not enough in these days to know that the price paid for a thing is a certain amount of money. An executor or administrator not only has to account for the amount expended, but also for what is obtained and why it is purchased. It serves no useful purpose merely to know that money has been expended; there should also be knowledge of what it has been expended for.

But consider the case of a pavement. Who certifies as to its quality? Who records its identification? Who is even held responsible for its existence? And where are there official records showing that every detail of the specifications under which it is built have been complied with?

When a purchase is made in private business a competent man is called upon to report whether the purchase meets the requirements of the purchaser and is value received for the purchase price. In the case of a street or road the value is passed upon, in ninety-nine cases out of a hundred, by an agency the least competent to judge and in a manner incapable of producing good results. Often the inspection is made by a pensioner acting as an inspector. Sometimes the procedure is worse—there is a blind inspection by a dignified city council, or a committee of that body, made after the street is completed and there is no way of seeing defects that should have been known before.

Study the Roads Already Built

A street is subject to everyday use as much as is a machine in a manufacturing establishment or a vehicle that travels over the street. Highway departments, educational institutions, and the government

* Abstract of a paper read before the American Society of Municipal Improvements, Oct., 1916

departments have deemed it advisable to construct various types of roads by various methods and with various materials with a view to studying them and keeping records of behavior, costs, traffic and the like. The conclusions reached after years of study are of doubtful character at best and are obtained from conditions differing widely from those actually existing on the streets. Why build a road for study? Why not instead study the roads built for use?

Counting the traffic passing over a street of any particular kind is no basis upon which to draw conclusions of any kind unless the traffic is considered together with a knowledge of exactly what it passes over. Why can not information of this kind be obtained in a more practical and scientific way so that it will be more reliable and will more nearly meet the necessities of the case?

There is no plan of street and road management or street administration that can be called fundamentally efficient, because there exists no plan of management that includes a certified copy of construction, maintenance and repair data, cost data, or any of the information sought in the building of so-called experimental roads. Streets that are improved are of various types. They are in various states of repair, and they are in various locations. A single street carries a variety of traffic and different sections of it carry different traffic. Different streets are built on different soils. Some are susceptible to easy natural drainage, and others must be drained artificially. Streets are generally built with the plans, specifications and the contract in the office of the contractor and under the direction of a foreman who has never seen either the plans or the specifications.

Chaotic Mismanagement

The type of improvement is determined to a greater or less extent by whims, by cheapness, by the influence of promoters—in almost every case from considerations other than those upon which good judgment depends. The streets when built evidence simply a lavish expenditure of money. But few of the streets and roads have legal names, most of them bearing only nicknames. There is no record of the original investment. The cost of upkeep is so confused with general charges against the whole pavement that there is obtainable no knowledge whatever as to the amount expended for it. There is nothing to show whether expenditures made for repairs are necessitated by wear and tear; by defects in the original construction; by accidents, or by cuts or openings. There is nothing to show whether a street has remained out of repair when repair was needed. This chaotic and inexcusable mismanagement has been allowed because the earning capacity of streets and roads has not been taken into account. Similar methods in a commercial establishment would lead to bankruptcy.

During the past twenty years streets have been improved practically without supervision—without accountability for results. No two contractors building the same kind of streets have built in the same way; each has followed his individual methods. The result is that ninety-nine per cent. of the defects found in streets are not due to ordinary wear and tear but to something else.

A Business System Must be Established

There must be established a business system that is fundamental, that will bear upon everything making for the economical expenditure of funds. Separate the streets into certain divisions and these divisions into sections not exceeding a mile in length. These sections must be measured, numbered and recorded for the purpose of complete identification. Put these divisions in charge of a competent engineer. When this is done a particular section can be treated as a thing, as a piece, as a machine, and it will be possible to record its efficiency, watch its weakness or its strength, its value and its behaviour, and record information of every kind. Similar data can be secured from every street within the corporate limits of the city, and with these data in hand the adaptability of various types of streets for varied kinds of service will in a short time become apparent.

By such a plan of road and street management the greatest economy could be secured, and in addition there would be the benefit of the information available for future work. Street and road improvement, maintenance and repair would at once become a scientific, systematic, business-like operation and wasted millions would be saved.

The Cement Gun in Canada

Mr. A. R. Roberts, Canadian sales manager of the Chapman Valve Manufacturing Company, Indian Orchard, Mass., has, in addition, been appointed Canadian sales manager for the Cement Gun Company, Inc., Allentown, Pa., his territory embracing all of Canada east of Alberta. The cement gun has shown itself as occupying an unique and important place in construction work in Canada as elsewhere. Among notable examples of gunite construction are the camp buildings at Camp Borden, the Ontario Hospital for the Insane at Whitby, waterproofing the reservoir of the Montreal Water and Power Company, etc. Indeed, the use of the cement gun has made possible the application of cement mortars to many entirely new methods of construction. Mr. Roberts is a graduate, B.Sc., of Cambridge, Eng., and was formerly connected in a technical capacity with the Canada Cement Company.

High Standard British Meters

The city of Montreal have just awarded one of the largest contracts ever placed in Canada for water meters to the Francis Hankin Company. The order is for British meters known as the "Helix," manufactured by the Leeds Meter Company, of Leeds, England. The majority of the meters are to be installed on the pipe lines leading to the Montreal harbor. All fire protection being on the far side of the meters, it was essential that as little pressure be lost as possible, and in the tests the "Helix" meter showed a loss of only 4¾ pounds. The Francis Hankin Company carry a large stock of all sizes of these meters at their Montreal warehouse.

Mr. Scully Canadian Representative

Mr. A. A. Scully, of Toronto, has been appointed Canadian representative for the F. C. Austin Drainage Excavator Company and the Municipal Engineering and Contracting Company, of Chicago. His territory will embrace all of Ontario and the Eastern provinces. The Austin Drainage Excavator and the Austin Cube Mixer are well known in the Canadian contracting field. Among the recent large work on which the Austin excavator was used are Camp Borden, government arsenal at Lindsay, New Toronto sewer, new International Nickel Plant at Port Colborne, etc. Mr. Scully has had a wide experience in the contracting field and knows the contractors' requirements. His offices are located in the Stair Building.

Benefits and Burdens of Road Improvement

Data Collected from an Economic Survey of Highway Work Indicates that the Outlay is Justified

IN order to obtain direct information as to the economic benefits and financial burdens imposed upon communities through the construction of systems of improved roads the Office of Public Roads of the United States made a series of exhaustive studies in eight selected counties, the results of which are incorporated in a recently issued bulletin, entitled, "Economic Surveys of County Highway Improvement." The studies were designed to cover a period of approximately five years, or a sufficient period to show the road improvement from its inception until such time as the full measure of its usefulness could be demonstrated. The counties selected were ones in which bonds had recently been voted for the construction of improved roads, and it, therefore, was possible to make a series of studies to cover the improvement from the outset to completion. Below are given excerpts from this bulletin dealing with a number of features that appear to be helpful examples to other municipalities contemplating large outlays for road construction:

The information which has been assembled during the years 1910 to 1915, inclusive, comprises general descriptions of the character and resources of the counties studied, the character, extent, and cost of the road improvement, the effect of the improvement on assessed valuation of property, the financial burden as indicated by tax rates, and the general prosperity and welfare of the respective counties as shown by output of local products, the character and amount of traffic, the saving in hauling costs, the incoming and outgoing shipments of freight by rail and water, the values of lands contiguous to the roads improved, the attendance at public schools, the character of school buildings, the number and distribution of population, and other related information. These studies were made at one-year intervals, and, as nearly as possible, exactly comparable information was obtained on each inspection. To reinforce these records a number of representative points were selected and photographs taken each year of these same locations, thus securing a pictorial record of the changes evolved from year to year.

Many claims and counterclaims are made as to the propriety of expending large sums of money for public road construction in local communities. One set of extremists ascribe to good roads nearly all the benefits and blessings which fall to the lot of humanity, while another set sees in large outlays for road construction only the spectre of debt and ruinous taxation. Somewhere between these two extremes must be placed the actual result produced.

The economic studies in the eight selected counties have brought out a number of features which cannot fail to prove helpful examples to other counties which contemplate large outlays for road construction. A comparative analysis of the most striking data obtained in the respective studies is, therefore, presented under appropriate headings.

Character of Bonds Issued.

In some of the counties comprised in the economic studies bonds were issued on the sinking fund plan, and in others the serial method was followed. Analysis of the methods followed in each case brings out some interesting points. One county, for example, issued $173,000 of 4.5 and 5 per cent. bonds, payable in 30 years, and callable after five years. It is impossible to estimate the total cost of retirement owing to the element of variability in the rate of retirement under this arrangement. In another county the bonds amounted to $350,000, payable in 30 years, at 5 per cent. Assuming the sinking fund to bear 3 per cent. interest, the total financial burden to the county for interest and the liquidation of the bonds during the 30-year period will be $745,702. That the method of financing the road improvement chosen by this county is not as economical as might have been selected is indicated by the fact that an equal amount of bonds at the same rate of interest, if issued under the deferred serial bond method, with the first bonds payable six years from the date of issuance and an equal amount payable each year thereafter for twenty-four years, would cost the county at the end of the thirty years $665,000, or a difference, as compared with the sinking fund method, of $80,702. If 4 per cent. could be realized on the sinking fund instead of 3 per cent., the saving for the deferred serial plan over the sinking fund plan would still be $47,216.

In the case of a third county the bond issues aggregate $250,000 and run thirty years, at 5 per cent. As in this case the sinking fund also yields 5 per cent. interest, the method of bonding is reasonably economical on the present basis. It is doubtful, however, if the sinking fund will continue to bring such an unusual return, and as soon as a lesser rate of interest is obtained or any of the sinking fund is not promptly invested, the sinking fund method will become more costly than the serial method which might have been adopted.

Another district adopted the deferred serial method, and had its bonds run from the fifth year to the twenty-sixth year. This is the only one among the entire eight which appears to have adopted the most prudent and economical method of handling the bond issue.

Some counties have issued bonds on the sinking fund plan, but subject to a redemption clause. A little investigation shows that this method is inferior to the serial method, and a net loss is effected. The practice of deferring the first serial payment is also expensive, as it has been found that a considerable amount could have been saved by making the first payment at the end of, say, five years, instead of deferring it for ten or more years. Extending the date of payment over a long period of years is a rather dangerous method, as it results in the indebtedness long outliving the estimated life of the improvements made.

Serial Method Most Economical.

It would seem that the most economical form of bond to issue is the deferred serial, with the first payment at the end of the sixth year and the payments then extending to a final term varying in length according to local conditions, but never exceeding thirty years. By having the first payment deferred to the sixth year the county has an opportunity to complete its road system and enjoy the benefits before beginning payment, but if the deferred period is much greater all of the evils of the sinking fund plan, with no corresponding merits, are adopted. If local communities

could profit by these examples the result would be the saving of many millions of dollars.

In one of the counties it was found that an amount probably aggregating as much as $5,000 had been lost to the county through a premature sale of the bonds—that is, in selling the bonds before the funds actually were needed. This resulted in the payment of interest much in excess of that which could be obtained upon cash balances in bank. Counties should pay due regard to this feature of road finance, even though the necessary precautions would save only a small amount.

Management of the Improvements.

In the eight counties selected several forms of management were in effect, and a noticeable tendency was demonstrated on the part of county authorities to select and designate for improvement a larger mileage of roads than the funds contemplated were adequate to construct. This was especially true in those counties where a considerable amount of grading was involved and where comparatively expensive types of construction were contemplated. Naturally these faulty estimates resulted in dissatisfaction and distrust among the taxpayers and to require either additional heavy outlays or the leaving of the project in a partially completed state. Judging from these examples, it is quite obviously essential that where any county contemplates comprehensive improvements involving large outlays and expensive types of construction the detailed advice and estimate of a competent highway engineer be secured before the people are asked to approve the bond issue. The experience of the counties covered by these studies indicates the wisdom of a statute in each state requiring a reliable estimate upon which bond elections should be based.

The road construction in these counties would seem to bear out the assertion which has often been made, that from 20 to 25 per cent. of the total road mileage of a county, if wisely distributed, will serve traffic needs to the extent of at least 80 or 85 per cent. of the total. In one of the counties included in these studies it was noted that the mileage is excessively large in comparison with the ton-mileage hauled over the improved roads. In this case it would seem that the county has overbuilt its improved road system and that a lesser mileage would have served its traffic needs.

Provision for Maintenance.

A question partly of management and partly of finance is involved in the experience of the eight counties in regard to road maintenance. It is a well-known fact that the general tendency is to neglect the maintenance of roads which have, in many cases, been built at great expense. In the case of a new New York county the state was directly concerned in the maintenance of the roads, and had complete control over such work on some of the roads and an indirect control over other roads, thus applying to the task a skilled management. In another county the work is conducted under an excellent provision of law, which specifies that an amount of not less than one mill on the dollar shall be levied to provide a maintenance fund for all of the roads constructed by means of bond issues, and this fund is to be kept separate from all other county funds, and can be used only for maintenance. As a result of this law these roads are not only in as good condition to-day as when completed, but have been actually improved. Thus the county's investment in good roads has not been allowed to deteriorate in the slightest degree.

One state has met the maintenance situation by providing that an annual tax of not less than 3 per cent. of the amount of bonds issued shall be levied to provide a maintenance fund. A conspicuous example of an emergency situation with reference to road maintenance is afforded in one locality, where no provision was made for maintenance of the bond-built roads. It was found that rapid deterioration was taking place and that insufficient funds existed with which to meet the situation. Accordingly toll gates were established on the principal roads and a sufficient revenue was derived from this source, not only to maintain the roads, but to actually extend the construction a short distance. This reversion to a system long since abolished by most countries is partly due to an administrative and fiscal organization under which the cities are not taxed for county purposes (although they may aid in the improvement of roads for a distance of ten miles from the city limits if the city council so elects). Thus it came about that while the cities contributed no part of the financial burden of maintaining the roads, they were, because of the heavy automobile traffic emanating from them, a very destructive element to the county road system. In view of the very rapid development of motor vehicles during the past decade and the prospects of much more widespread use of this means of transportation in the future, the desirability of making provisions so that the cities may aid in the construction and maintenance of roads in the surrounding territory.

Economic Benefits.

In arriving at an estimate of the benefits which a county receives through the improvement of its public roads, certain factors must be taken into account more as the media by which the benefits may be measured than as the actual benefits themselves. While it is realized that the increase in the value of land must not be added to the saving in hauling costs, the convenience and access to schools, markets, churches, etc., but is rather the effect produced by those causes, it is perhaps the best index which can be obtained as to the economic value of the roads to the community. A study of the increase in the values of farm lands in the eight counties reveals the rather interesting fact that following the improvement of the main market roads the increase in the selling price of tillable farm lands served by the roads has amounted to from one to three times the total cost of the improvements. The increase in values in those instances which were recorded ranged from 9 per cent. to 194 per cent. The estimates of increase were based for the most part upon the territory within a distance of one mile on each side of the roads improved. These estimates are not claimed to be mathematically exact, but it is believed that they will give a fairly accurate indication of the results which may be expected under similar conditions.

Saving in Hauling Costs.

In dealing with the effect of road improvement upon the hauling of commodities, the method has been adopted of ascertaining the traffic area served by each road much in the same manner as the drainage area of a stream is ascertained. After determining such areas the character and amount of production is ascertained and an estimate is made as to the proportion of the tonnage produced which is hauled upon the roads. A further investigation is made as to shipments by rail in and out of the county, and information is obtained from census reports and from merchants and producers to verify the results obtained from the traffic-area calculation and the freight-tonnage enquiry. In some cases an actual traffic count or census is taken to determine the tonnage hauled upon the roads. From these

various sources it is possible to arrive at a reasonably accurate estimate of the tonnage hauled over the improved roads. It is a comparatively easy matter to determine the average length of haul in each case and the prevailing rate of wages for men and teams. With these factors the total tonnage, the total ton-mileage, and the cost per ton-mile before and after the improvement of the roads are computed. The saving in traffic represented by the road improvement is thus expressed in dollars. It is, of course, realized that the figures given do not represent an actual "dollars and cents" saving, as many of the men and teams figured in on a wage basis might have been idle if they had not been engaged in hauling the products of farm and forest. But they, at least, indicate the saving in time and energy, and these have a monetary value. Therefore, the saving to traffic in each county is stated for the purpose of indicating to readers a relative figure by which they can determine the waste due to a system of poor roads. Considering the eight counties in the aggregate, the gross annual saving in hauling costs due to their good roads systems affords the rather impressive total of $627,409 for a traffic of 3,489,652 ton-miles. The average gross saving per ton-mile for the eight counties is 17.8 cents, this being indicated by an average rate of 33.5 cents before the roads were improved, as compared with 15.7 cents after the roads were improved.

In order to determine the net saving on a ton-mileage basis it is necessary to deduct from the gross saving the estimated annual outlay for interest and retirement of the bonds and for interest on the value of aid received from the state or from any source other than the bond issue. The annual cost of maintenance should be considered as a partial offset to the saving in hauling costs if the outlay for maintenance is greater after the roads are improved than before improvement. That the cost is greater after improvement can scarcely be doubted, as real maintenance was scarcely in effect at all before the roads were improved.

Effect of Road Improvement on Schools.

A comparison of the effect of the road improvement upon country schools affords probably a more complete vindication of the outlay than even the material features which have been presented. Combining the results obtained in all of the eight counties, it appears that before the roads were improved the average school attendance was 66 pupils of each 100 enrolled, as compared with 76 after the roads were improved. A consideration of this showing must reveal the fact that the good roads have been materially responsible for the education of ten children out of each hundred. As the struggle for existence becomes keener in the years that are yet before us, the educational training which the children receive in the country schools will make itself felt more and more in the material and moral success of the man and woman. Not only have the roads contributed toward a larger school attendance, but they have been quite instrumental in lifting the standard of instruction by making easier the consolidation of little one-room schools into graded schools. In one particular county the system of taking the children to and from school by means of wagons has been adopted since the roads were improved.

Taking it from all of these angles, the experience of the eight counties has demonstrated that the beneficial effects of the road improvement justified the outlay, and that, while more efficiency and economy might have been obtained in some cases, the loss was not such as to make the citizens of any of the counties feel that the move for better roads had been an unwise one.

The Engineer

By Dr. Frank Crane

THE man of the future will be the engineer.

He is the man who can DO things; and is better than the man who OWNS things.

The millionaire is a temporary, passing, makeshift product of civilization. He is merely holding things together until the people get sense enough to do their own owning.

Some day little boys will read that the world once had millionaires and huge private wealth units, just as they will one day read and wonder that men once had kings.

But the official who will forever be indispensable is the engineer.

The time will come when the head of the state will be chosen as the man who has the greatest talent and skill in organizing public works. There will be no more politics in his selection than there is now in choosing the master mechanic of a railway or factory.

When a nation goes to war nowadays—that is, when it becomes necessary to exert its supreme collective strength—nobody dreams of electing the most popular politician or the cleverest speechmaker to lead the armies. It is the man who can get the last ounce of efficiency out of men and metal that is wanted.

Some day the nation will realize that it is continually in a crisis, and that in peace, as in war, we need the highest order of efficiency and organization.

We need the engineer to arrange the transportation of people and goods from place to place, without waste, without competition, without graft, looking only to the public good.

We need the engineer to get meat, bread, and milk from farm to citizen, without the present inefficient tangle of trusts and middlemen working at cross-purposes.

We need the engineer to turn the public enterprise toward building good roads and bridges, instead of enriching a few shrewd manipulators.

We need the engineer to manage a city as economically and smoothly as if it were a manufacturing plant.

We need the engineer to organize the farmers so that all can work together for each, and their products be marketed without being preyed upon at every step of the way from farm to household.

Wealth can be taken away from us. But the power to DO things cannot be taken away.

The millionaires could go and not be missed. The engineers we cannot spare.

"What availeth all thy wealth?" said the ancient philosopher. "He that hath better iron than thou will come and take away all thy gold."

Says H. L. Gantt:

"The man who knows what to do and how to do it is pre-eminently the engineer. The new world which is being ushered in by the great struggle now taking place is one in which the engineer is destined to be the supreme power, for it is becoming clear that, in future, the man who OWNS THINGS will not be as important a factor in the world as the man WHO CAN DO THINGS."

Sir Lomer Gouin, Premier of Quebec, has been petitioned by the Montreal Builders' Exchange to allow direct representation of the exchange on the board of directors of the Montreal Technical School. The main contention is that such representation will be for the mutual advantage of the community and the school.

Tests on Lead-Caulked Joints*

IN connection with the construction of Port Arthur's water system, before pipe laying was commenced a series of tests of lead-caulked joints was carried out, and for this purpose some lengths of 12-inch pipe were used with a valve at each end of the line. The pipes were on blocking and standing free, and in all there were four joints. A small hand pump was rigged up, having a displacement of three cubic inches per stroke.

The foregoing tests were made within a few hours of making the joints, and in order to ascertain what advantage there would be in leaving the joints for several weeks, a test was conducted four weeks later on pipes caulked when the above tests were made. In this test three joints were caulked with lead wool and the fourth with lead wire ⅜ of an inch in diameter. When the test was applied the pressure was gradually raised to 500 pounds per square inch with no perceptible sweating. When raised a few pounds higher one of the joints suddenly moved 1½ inches. The arrangement of pipe was similar to the previous tests.

One test was also applied on the 24-inch pipe as above, there being four joints in all, caulked with run lead, lead wool and lead wire. When the pressure reached 120 lbs., the run lead joints gave out. On account of cold weather no further tests were made.

It should be noted that the pressure exerted on the 12-inch gate at 500 lbs. per square inch, was 56,550 lbs., and on the 24-inch, 54,286 lbs. and 120 lbs. pressure.

Some points brought out in the tests are:—

Tests Performed on 3/16 in. x 12 in. Steel Bell and Spigot Pipe

Test No. 1

Pressure	Joint No. 1 Run Lead	Joint No. 2 Lead Wool	Joint No. 3 Run Lead	Joint No. 4 Lead Wool
110 lbs.	Sweating slightly	Sound	Sound	Sound
125 lbs.	Sweating freely.	Sound	Sound	Sweating slightly
150 lbs.	Dripping freely	Sound	Sound	Sweating freely
200 lbs.	Dripping freely	Sound	Sound	Valve started to move off leaking freely
225 lbs.	Dripping freely	Sound	Sound	Valve moved off 2½ in., leaking freely

In the above test the protective solution was left on spigot and bell.

Test No. 2

Pressure	Joint No. 1 Run Lead	Joint No. 2 Lead Wool	Joint No. 3 Run Lead	Joint No. 4 Run Lead
110 lbs.	Sweating slightly	Sound	Sound	Sound
150 lbs.	Sweating	Sound	Sound	Sweating slightly
200 lbs.	Sweating freely	Sound	Sound	Valve jumped 1 inch, and leaking freely

The spigot at joint was cut off and solution left on.

Test No. 3

Pressure	Joint No. 1 Run Lead	Joint No. 2 Lead Wool	Joint No. 3 Run Lead	Joint No. 4 Lead Wool
200 lbs.	Sound	Sound	Sound	Sweating slightly
300 lbs.	Sweating slightly	Sound	Sound	Dripping
350 lbs.	Sweating freely	Sound	Sound	Running
400 lbs.	Moved ¼ in.	Moved ⅛ in., not leaking	Moved ¼ in., dripping	Running freely
450 lbs.	Lead started to blow	Sweating slightly	Moved 1 in.	Running freely but had not moved

Pipes were clamped in this test only, as shown on sketch. At 450 lbs. the pipe buckled at joint No. 3.

Test No. 4

Pressure	Joint No. 1 Run Lead	Joint No. 2 Run Lead	Joint No. 3 Run Lead	Joint No. 4 Run Lead
200 lbs.	Sound	Sound	Sound	Sweating
275 lbs.	Sound	Sweating freely	Sound	Sweating
290 lbs.	Sound	Jumped ¼ in., dripping	Sound	Sweating
300 lbs.	Sweating slightly	Dripping freely	Jumped ½ in., leaked badly	Dripping freely
340 lbs.	Sweating slightly	Dripping freely	Leaking badly and moving	Dripping freely
390 lbs.	Sweating slightly	Dripping freely	Moved 1 in., lead started to blow	Dripping freely

The spigot ends of all pipes were well scraped and brightened.

Test No. 5

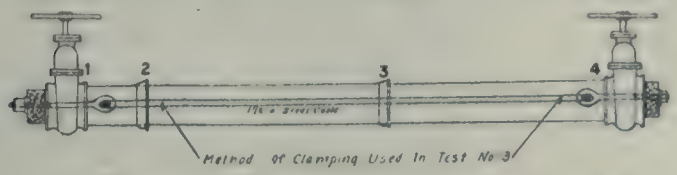
Pressure	Joint No. 1 Run Lead	Joint No. 2 Run Lead	Joint No. 3 Run Lead	Joint No. 4 Run Lead
150 lbs.	Sweating slightly	Sound	Sound	Sound
200 lbs.	Sweating slightly	Sound	Sound	Sound
225 lbs.	Sweating freely	Sound	Sound	Sound
250 lbs.	Sweating freely	Sound	Sound	Sound
275 lbs.	Sweating freely	Sound	Sweating slightly	Sound
290 lbs.	Sweating	Sound	Jumped 3-16 in.	Sound
340 lbs.	Sweating	Sound	Moved ¾ in., lead started to blow at bottom	Sound

In this test 1¾ in. to 2¼ in. of lead were used in each in each joint instead of from 2½ in. to 3¼ in. during the previous tests.

* From a paper by Mr. L. M. Jones, before Canadian Society of Civil Engineers.

1. It is evident that lead wool makes a better joint than run lead and lead wire better than lead wool.

2. That a depth of lead from 1¾ inches to 2 inches from the face of the bell is cheaper and just as efficient



The arrangement of experimental pipe line as used in test No. 3.

as a greater depth. Caulking had no effect on the lead beyond this depth.

3. The clean spigot allows of a better joint being made than one having a covering of solution.

4. That the run lead joints gave better results when pressure was applied about four weeks after making, than immediately after being made.

5. That none of the lead blew from the joints until considerable movement had taken place in the joint.

6. That better results would have been obtained had the pipe been laid in the trench and properly covered, for the reason that no movement would have taken place in the pipes if bends were anchored.

7. It is evident that all bends of considerable angle should be anchored to prevent movement. This was very clear with regard to the 24-inch pipe.

The Capital Ship of the Future

EVERY student of naval technique who cherishes his own theories about warship design thinks with envy of the rich mass of data which, by this time, must have accumulated at the Admiralty. Although no really decisive encounter has taken place, the past two years have been singularly fruitful and instructive from the technical point of view. Vessels of every type and class have been in action. Super-Dreadnoughts and battle-cruisers have met their "opposite numbers," light cruisers have repeatedly been engaged, and the smaller fry of the flotillas have put in a prodigous amount of work, both above and below water. Every weapon in the modern naval armoury has been fully tested, not once but many times. And, on the whole, the result has been eminently creditable to all who have had a share in forging and fashioning those weapons. Naval construction is not yet an exact science. In spite of the many formulae and well-defined rules, based on past experience, which guide the designer of fighting ships in his work, there still remains an element of uncertainty as to whether the completed ship will behave in given circumstances as she is intended to behave. It is a truism that every warship represents a compromise. Years ago the warship problem was compared in these columns to a differential equation which has an infinite number of solutions; but, it was added, there is always a particular solution corresponding to each particular case, and the best is obtained when the elements of armament, armour, coal capacity, speed, and tactical qualities are assigned to their proper relative proportions, with regard to the work to be done and within the limits of the displacement available. This is perfectly true of the theory of design. But in warship design there can be no finality, and though to-day we are nearer the ideal type than was the case ten years ago, every new conception suggests by its very qualities the direction in which still more perfect results are to be sought.

The Supremacy of the Capital Ship.

In this article we shall confine our attention to the capital ship; first, because the test of war has re-established its claim to supremacy in the naval hierarchy, and, secondly, because it has undergone changes far more revolutionary than those which have marked the evolution of lesser types. Between the capital ship of 1904-5, with which the last great naval war was fought and won, and the capital ship of the present day, there is a difference out of all normal proportion to the brief period of time that divides them. The displacement has practically doubled, the destructive power of the armament trebled or quadrupled, and if the other elements of battle efficiency, such as speed and protection, show progress rather less startling, it is only because their development is retarded by physical obstacles which an incautious critic might pronounce insuperable. Nevertheless, the rise in the speed of the capital ship within the last decade is, perhaps, the most remarkable feature of all. Ten years ago our fastest armoured ship was the Drake, with a maximum speed of 25.3 knots. To-day there are vessels of more than twice the displacement which can better her performance by five knots, and it may be that if all the facts were known figures still more striking could be adduced. The problem of enabling the ship to resist attack is hedged about with graver difficulties than beset the gun maker or the engineer. Means of offence have entirely outstripped those of defence. It is many years since the last noteworthy improvement in the manufacture of armour was recorded, in spite of unceasing experiment and patient research by the chemist and the metallurgist. But the gun has grown so rapidly in range and power that in place of the 40 calibre 12-in. weapon which discharged its 850 lb. projectile with a muzzle energy of 39,280 foot-tons, we now have the 45 calibre 15-in. gun, which fires a 1,950 lb. projectile with a muzzle energy of 84,500 foot-tons. Yet the quality of armour has remained all but stationary, and the slightest increase in thickness involves the addition of many hundred tons of dead-weight for a very problematical gain in protection. Unless some really important improvement in the resistant properties of armour is introduced, it appears likely that the system of protection adopted in the United States, where the latest vessels are given 14 inches to 18 inches of armour over vital parts and none elsewhere, will become universal. Against the mammoth projectiles of the modern gun, more comparable to explosive meteorites than mere shells, the thin armour with which many of the older capital ships in the world's navies are fitted can offer no real protection. Even those battle guns which are now regarded as of medium calibre, such as the 11-in. and 12-in., have shown themselves to possess extraordinary ballistic properties. The German 50 calibre 12-in. gun, with its enlarged powder chamber and high initial velocity, is a very formidable weapon, possibly outranged by our 13.5 in. model, but capable of great

destruction inside 16,000 yards. And all the signs point unmistakably to a further growth in the power of naval ordnance. Great Britain, Germany, and Italy each have ships built or completing which are armed with 15-in. guns. As the mechanical and optical appliances which have made long-range gunnery feasible are brought to still higher stages of perfection there will be an irresistible tendency to increase the power of the individual gun. It is only eight years since a well-known naval writer foreshadowed the building of a 33,000-ton battleship, to carry eight 18-in. guns. Though he put the probable date of its construction as far ahead as 1925, his forecast was looked upon as too fantastic for serious consideration. Yet the American battleship Pennsylvania, now completing, is barely 600 tons short of the displacement of this imaginary mastodon, and it is scarce three years since Mr. J. M. Gledhill, of Armstrong, Whitworth and Company, told the members of the Iron and Steel Institute that there were "now whispers concerning a gun of 18-in. bore and weighing between 150 and 200 tons."

The King of Weapons.

The big gun is still the king of weapons, and those confident prophets who foresaw the metamorphosis of the capital ship from a floating gun-platform into a huge torpedo-carrier have been put out of countenance by the lessons of the last two years. The problem which the naval designer will have to solve in the near future remains substantially the same as that which he has solved, more or less successfully, in the past. He will not be asked to design a capital ship possessing the faculty of submersion, for the business of the capital ship is not to run away but to fight. The vision of submarine Dreadnoughts bobbing up here and there to fire at the enemy, and vanishing into the depths after each salvo, is not one that appeals to the practical mind. The capital ship of the future promises to be remarkable more for gun-power and speed than for its powers of occultation. To design a capital ship with the maximum amount of battle energy, and to give her besides the greatest power of endurance compatible with more positive fighting qualities, remains the task of the naval constructor. But the problem is less simple than it was. Twenty years ago offence and defence could be stated in terms of guns and armour plate. The torpedo and the mine both existed, but both were still too primitive to exert any appreciable influence on construction. In the capital ships of that era we may discern some recognition of the possibilities of underwater attack, for every vessel of importance was fitted with a double bottom and water-tight compartments. These, however, were as much a concession to the ram and to the ordinary hazards of navigation as to the mine and torpedo. Not until the Russo-Japanese War had demonstrated how the most powerful capital unit was liable to disablement or summary destruction by under-water explosion was special attention paid to the new menace. From that time onward an ingenious combination of sub-division and armoured longitudinal bulkheads was worked into most capital ships. Germany, it may be mentioned, plumbed the question with characteristic thoroughness. Several obsolete vessels, after being refitted with the most approved systems of under-water defence, were subjected to mine or torpedo attack, and the practical experience thus derived was embodied in new construction. Possibly the most noteworthy early example of internal defence against submarine explosion is presented by the French coast-defence ship Henri IV., in which ship an immense amount of armour was worked into the lower portions of the hull. In addition to flat decks both above and below the main belt there are lateral armoured bulkheads which extend downwards from the lower armoured deck to the bilge keel line, and the side below the belt amidships has 3-in. plating down to a considerable depth. The total weight of armour in this small ship is 3,500 tons, or nearly 40 per cent. of the entire displacement. That the new measures were partly efficacious has been proved by the manner in which certain modern ships have survived the explosion of torpedoes. The French battleship Jean Bart, attacked by an Austrian submarine, was able to make her way to a base several hundred miles distant, where she was very quickly repaired. In the Battle of Jutland Bank the Marlborough was struck by a torpedo and took up a considerable list to starboard, yet in spite of the damage she kept her place in the line and reopened fire nine minutes later. More recently the German battleship Westfalen was successfully attacked by a British submarine. At least one torpedo got home, but the Germans claimed that the second went wide, and that the vessel was brought safely into port. On the other hand, many older vessels, built before the torpedo had become a serious menace, have succumbed to a single blow. The torpedo, however, like the gun, is rapidly increasing its potency. From 14 inches the diameter has risen to 21 inches, and in the latest models the war-head contains about 300 lbs. of trinitrotoluol. A few years hence these figures will be surpassed, for there are no technical difficulties in the way. Hitherto it has been necessary to keep the weight and length of torpedos within reasonable limits in order to facilitate their handling. But as destroyers and submarines grow larger and able to carry heavier weights, the need for restricting torpedo dimensions will no longer obtain. Thus, what is considered adequate internal protection against existing torpedoes may be powerless to resist the attack of the more formidable weapons which are sure to appear in a few years' time.

Submarine Has Modified Naval Operations.

Though the submarine has not proved itself as formidable a tactical factor as Admiral Sir Percy Scott and several other authorities apprehended before the war, it has unquestionably modified naval operations both tactically and strategically. Through its agency the torpedo has ceased to be a remote and casual danger, to counter which certain precautions of a somewhat perfunctory nature were deemed sufficient. Not even a close screen of destroyer patrols can always guard a capital ship against submarine attack; and as for the torpedo nets on which reliance used to be placed, these have been shown up as a snare and a delusion. The construction of submarines with speed and manoeuvring qualities vastly superior to the present standard will be made possible by improvements in the internal combustion engine. Boats of this description will obviously constitute a much greater danger to the capital ship, for their speed and handiness will give them more opportunities to attack than the present-day submarine enjoys. And their attack, when delivered, will be the more effective owing to the deadlier torpedoes with which they will be armed. It is apparent, therefore, that the capital ship will henceforth have to reckon with torpedo attack under all conditions, and unless given means to resist this form of assault it will at all times be exposed to the risk of sudden destruction. Whether the significance of this fact has been fully grasped by those whose

business it is to design our warships can only be conjectured. Many years elapsed between the introduction of the shell gun in foreign navies and the building of armour-plated ships in our own. There was an almost invincible prejudice against armour, and it was not until the battle of Sinope and other naval incidents in the Near East had revealed the tremendous effect of shells against unprotected wooden ships that the authorities began seriously to consider the adoption of armour. But in a very short time after the first cautious step had been taken the building of ironclad ships became general, and designers ceased to be appalled at the notion of devoting about 30 per cent. of available displacement to iron plates. Fortunately the traditional conservatism of the Navy has been less in evidence of late years, and especially during the war have our constructors shown great boldness and adaptability. The "torpedo-proof" monitors sent to the Dardanelles are a case in point, and there are countless other instances which it is not expedient to cite. In view of the good results which have been attained in this direction, when time was limited and everything had to be improvised, it is not too much to hope that still more effective work will be possible when we revert to normal conditions. The really efficient capital ship of the future will be a vessel which, in addition to having the highest qualities of armament and protection against gun-fire, will be virtually immune from serious damage by underwater attack. In all likelihood this immunity will be conferred by some modified form of the girdle which has been fitted to the monitors. To dispose this belt in such a manner as not to diminish speed, yet to make it proof against the strongest torpedoes likely to be produced, will be a knotty problem to solve. A considerable increase in displacement must be looked for, as the adoption of the new belt will entail greater breadth; which, unless it be found possible to fine the ends of the ship and thus obtain a finer block coefficient, will call for more engine power to attain the desired speed. On the other hand, an important saving could be effected by discarding the armoured topedo bulkheads below water, since if the anti-explosion belt did its work these would be superfluous. We may add that, to be thoroughly effective, this system of resisting explosion should extend over the whole underbody of the ship, for a belt merely deep enough to arrest torpedoes would not necessarily afford protection against mines. No system of internal protection, however elaborate, which depends on armoured bulkheads and subdivision, is likely to prove as satisfactory as the explosion-proof belt or cofferdam. This has been demonstrated both by experiments in peace and by the test of war. Longitudinal protective bulkheads, especially when placed too near the side of the ship, may actually constitute a source of danger. In a paper read before the Institution of Naval Architects mention was made of one experiment in which a thick bulkhead, fitted at the usual distance from the side, was broken up by the force of a submarine explosion and was hurled through the inner bulkheads, wrecking the boilers in its course, more damage resulting apparently than if the outer bulkhead had not existed. To prove really effective, it has been stated, the outer explosion bulkhead ought to be at least 15 feet from the side of the ship. This suggests the possibility of filling the intervening space with some shock-absorbing and water-excluding material. Such an arrangement would certainly mean the pre-emption of much valuable space, but it would not be too high a price to pay for almost absolute immunity from a particularly dangerous form of attack.

The Naval Power which is first in the field with a squadron of capital ships proof against both torpedo and mine will enjoy an advantage difficult to overestimate. The indecisive character of naval operations in the present struggle has been largely owing to the development of underwater attack. At the Dogger Bank engagement of January 24th, 1915, the German battle-cruiser squadron would probably have suffered far more severely than it did had not the necessity of safeguarding his ships against submarines and mines compelled the British Admiral to relax the pursuit. Again, there is every reason to believe that the Battle of Jutland Bank would have been renewed on June 1st with decisive results had not the night dispositions which Admiral Jellicoe was forced to make in order to preserve his Fleet from destroyer attacks allowed the Germans to slip back to their ports under cover of darkness. The consciousness of immunity from torpedoes and mines would, in fact, be an asset of incalculable value to any commander, however bold and resourceful he might be. It would enable him to pursue tactics which are entirely ruled out in existing conditions, and to exploit to the utmost his superiority in gun-power and speed. A point so obvious as this does not need to be laboured.

The Future Capital Ship.

Reviewing the experience of the war to date, we may safely conclude that capital ships will continue to form the backbone of every fleet, and that they will steadily grow in size and cost. The suggestion heard early in the war, when submarines were claiming many victims, that great armoured ships were useless luxuries, and that command of the sea could be secured by submarine torpedo craft alone, is now seen to be fallacious. There is no short cut to sea power. In the future, even more than in the past, that power will be expressed in squadrons, each unit of which will cost as much as a whole division of older capital ships. The demand for larger guns, higher speed, thicker armour, and protection against submarine explosion bids fair to lead to the construction of ships which will as far outclass the early Dreadnoughts as the Dreadnought outclassed the Formidable type. Heavy as the burden of armament promises to become in future, it is consoling to reflect that the almost prohibitive cost of the capital ship will render it impossible for any single State to inaugurate such an era of feverish naval expansion as that for which Germany was responsible in recent years.—The Engineer.

Complete Building Exposition

A feature of the National Complete Building Exposition that will appeal peculiarly to the average building contractor will be the special divisions illustrating the very latest development in commercial, factory, church, and theatre construction. In expanding the educational policy of the exposition it is planned to make these special exhibits as complete and comprehensive as possible, while in no degree minimizing the home-building interest, which is really the foundation upon which the show is laid. Much interest will attach also to the community exhibits to be put on by the several associations promoting the welfare of asbestos, tile, metal, and slate shingles, hollow and self-facing tile, metal lath, cement, concrete, terra cotta, gypsum, and vitrified clay products. These will be unusually elaborate, and will show most effectively the possibilities of each particular material. The exposition will be held in the Grand Central Palace, New York, March 5-11, 1917, and will provide many interesting pointers for the enterprising and up-to-date contractor.

The Fundamental Principles of Reinforced Concrete Design

By Mr. E. McCullough

Reinforced concrete is a combination of concrete and metal, preferably steel, with the two materials so disposed as regards position and amounts that each resists the stresses it is best fitted to resist. In piers, posts and columns the concrete takes compression assisted by the steel, and the vertical steel takes tension if any bending occurs. In beams three stresses act; namely, compression, tension and shear. The concrete takes all compression and a limited amount of shear. The steel is computed as taking all the direct tension and assists the concrete to carry shear.

Let us consider a reinforced concrete column 8 x 8 ins. outside dimensions. The steel will be in the form of four bars each ½ in. square. The bars are set in the corners, as shown in Fig. 1, and 1½ in. in from the sides of the column. This is specified for fire protection. The concrete outside of the steel (used for fire protection) assists in carrying the load until the fire comes, but after a severe fire it should not be depended on, so we neglect it entirely in our computations. The actual area of the columns is therefore 5 × 5 = 25 sq. in. Four ½ in. square bars have an area of one square

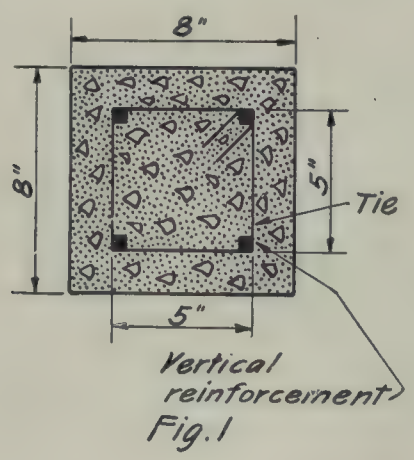


Fig. 1

inch. The ratio of steel to concrete is 1 ÷ 25 = 0.04. The steel ratio multiplied by 100 is the per cent. of steel reinforcement. Our column therefore contains 4 per cent. of steel, the maximum for a column of this type. Some building ordinances limit it to 3 per cent., following the lead of Chicago.

When a load is applied to the top of a column and the steel bars get their share they bend because the slenderness ratio (the ratio of length to thickness) is large. It is necessary to put ties around the upright bars and these ties are spaced at intervals not exceeding twelve times the thickness of the vertical bars. Therefore, in the column under consideration, the ties will be spaced 6 inches apart because the bars are only ½ inch square. The ties are held in place by No. 18 black stove wire and the ends are turned in far enough to be gripped by the concrete so they cannot be pulled out when stressed. Ties are usually made of heavy wire or ¼ or ⅜-inch round steel rods.

Having arranged the bars and the ties, how much will our column carry?

Let us assume a 1:2:4 concrete with an allowable fiber stress in compression of 400 lbs. per sq. in. The area of the concrete is 25 sq. ins. less 1 sq. in. of steel = 24 sq. ins., which at 400 lbs. gives 24 × 400 = 9,600 lbs. To determine the strength added by the steel we must be governed by the ratio of deformation between the steel and concrete. This, for the concrete we are using, is 15, as determined by experiments.

Assume a piece of steel fastened in a vertical position and a load placed on top. Assume a piece of concrete of the same size similarly placed and loaded with an equal load. Careful measurements will show that both materials shorten under the applied loads but the decrease in the length of the steel is 1/15 that of the concrete. To produce equal shortening (deformation) under equal loads the cross-sectional area of the concrete must be 15 times the cross sectional area of the steel. Thus each square inch of steel is equal to 15 square inches of concrete.

Now apply this to the column in question. The area of concrete is 24 square inches. The area of the steel is 1 square inch, the equivalent of 15 square inches of concrete. Consider the area of concrete to be increased, making it 24 + 15 = 39 sq. ins. The load-carrying capacity of the column is now 39 × 400 = 15,600 pounds. The average stress is 15,600/25 = 624 lbs. per sq. in., an increase of 56 per cent. The unit stress on the steel is 15 × 400 = 6,000 lbs. per sq. in.

A safe compressive stress for the steel alone would be 12,000 pounds per square inch, which shows that it is not economical to use steel in compression in reinforced concrete, except in columns.

We cannot use a steel stress exceeding the concrete stress multiplied by the ratio of deformation or the concrete will be stripped from the steel and the column will fail. The two materials must act together and shorten equally, each carrying a proportion of the load. The ratio of deformation is therefore a stress ratio for columns or for members acting wholly in compression.

The following formulas are used for the design of columns in which the unsupported length does not exceed 15 times the effective diameter or thickness; that is, the thickness of the column after deducing the protective covering of the steel.

Let f = average unit stress per sq. in. of effective area.
f_c = allowable unit stress per sq. in. on plain concrete.
p = ratio of steel to concrete.
A_c = area of concrete in sq. in.
A_s = area of steel in sq. in.
A = total effective area = $A_c + A_s$.
n = ratio of deformation.
P = total load.

then $P = Af = f_c (A_c + nA_s)$.
or $f = f_c [(1-p) + np]$.

The Hooped Column

Make a cylinder of thin paper and fill it with sand. The paper is barely strong enough to hold the sand and if a load is put on top the paper will burst and the sand will flow. Use a tin cylinder and the pressure required to burst it will be very great. Instead of sand use cement mortar or concrete and the metal casing can be made very thin, so thin, in fact, that a wire wound spirally around the concrete cylinder will furnish the necessary strength provided the amount of metal in the wire is equal to the amount found to be necessary in the solid thin shell. Poorly made concrete needs more reinforcement than first-class concrete.

The hooped column consists of a concrete core reinforced with vertical steel and having a steel spiral around the core. There should be not less than eight vertical rods not exceeding 6 per cent. of the area. The spiral hooping

should be not less than one-half of one per cent. and not to exceed one and one-half per cent. of the area. More than this amount is wasteful, for it adds little strength. The spiral does not act until the concrete begins to fail and as it postpones the total failure the effect is the same as increasing the strength of the concrete in compression so we can use 20 to 25 per cent. higher unit stress, depending upon the building ordinance followed. Steel in the form of a spiral, provided it has a pitch not exceeding one-sixth of the diameter, is 2.4 times as effective as the same amount placed vertically. The vertical equivalent of spiral steel is found as follows:

Let c = circumference of the core in inches.
x = pitch of spiral in inches.
a = cross sectional area of steel used for spiral.
A = Area of core in sq. in.

Then the equivalent ratio of spiral per ft. of length $= 1.1 \frac{ca}{Ax}$

The strength of the hooped column is

$$P = f_c\,(A_c + nA_s + 2.4nA_b)$$

in which A_b = area of spiral steel, in terms of vertical steel.

$$\text{or } f = P/A = f_c\,[(1-p) + np + 2.4np']$$

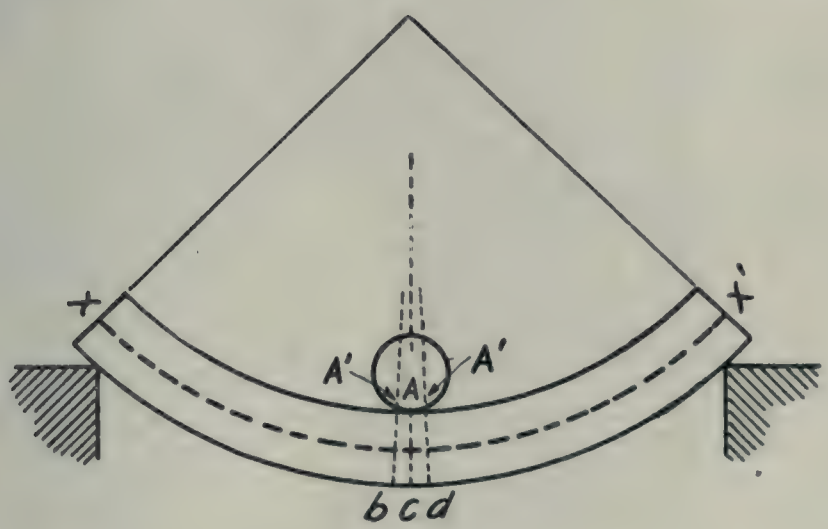


Fig. 2

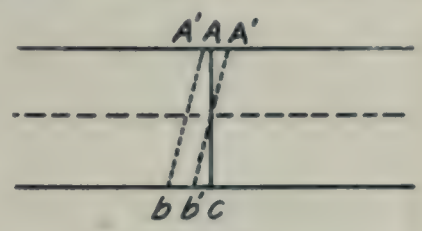


Fig. 3

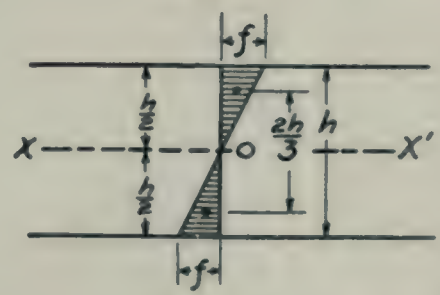


Fig. 4

in which p' = ratio spiral steel expressed as equivalent vertical steel.

In Fig. 2 is shown a beam bending under load. In the middle of the span is shown a vertical line A c, an extension of a radial line. On one side of this line is a radial intercept A'b and on the other side a radial intercept A''d.

Provided the material is homogeneous, that is, uniform in quality and strength, and is not stressed beyond the elastic limit, a vertical section plane before the beam bends is plane after it bends. That is, A c is straight before the load is applied and the lines A'b and A''d are also straight although the horizontal separation bc is greater than AA' and cd is greater than A A''. In Fig. 3 the line A'b is assumed to be moved across Ac so the space A A' = b'c. This is equivalent to revolving the line Ac until it becomes A' b', parallel to A'b.

In Fig. 4 this is again shown to illustrate the two force triangles, the upper one representing compression and the lower one tension. The material being homogeneous the neutral axis x.....x' is midway between the top and bottom edges. The force triangles are therefore equal, the stress being zero at the neutral axis and a maximum at the edges. The maximum unit stress (skin stress some men call it) is designated by the letter f. The average stress is f/2

The area of each force triangle is $\frac{f}{2} \times \frac{h}{2} = \frac{fh}{4}$.

We have been considering a thin slice of a beam, and as a beam has breadth we will use the letter b (breadth) to designate this. Our force triangles now become wedges each with a volume = fhb/4.

Forces act through the centre of gravity of bodies and the centre of gravity of a triangle is h/3 from the base. The distance between the centre of gravity of the two force triangles is 2h/3 as shown in Fig. 4.

The total compressive force is equal to the total tensile force exerted to resist bending and each force wedge acts with a moment arm = 2h/3, so we obtain the moment of resistance by multiplication, thus $M = \frac{2h}{3} \times \frac{fbh}{4} = \frac{2fbh^2}{12} = \frac{fbh^2}{6}$ for a rectangular beam of homogeneous material; that is, one in which (below the elastic limit) the tensile strength equals the compressive strength.

In Fig. 5 is shown, a beam made of two pieces with a hinged joint. In the top of the joint is a block of rubber and at the bottom is a coiled spring. When a load is placed on top the beam will, of course, bend at the hinged joint. It requires no effort of imagination to prove that in the top of the open joint the tendency to close is opposed by the rubber and in the bottom the tendency to open is opposed by the spring. Actually the hinge midway is not required. It merely locates definitely the position of the neutral axis, and to consider the hinge as a necessary feature is likely to confuse one as to the action of resisting forces in a beam. The neutral axis is the point where the character of stress changes from tension to compression, or from compression to tension. In a beam of homogeneous material, that is, one in which the tensile and compressive strengths are equal, with symmetrical cross-section, the neutral axis will be midway between the top and bottom surface, or skin. At the skin the stress is a maximum. At the neutral axis it is zero. A diagram illustrating this is triangular and is termed a force triangle.

In Fig. 6 (a) the compressive triangle has vertical lines and the tensile triangle has horizontal lines. Each triangle overlaps the other and the heavily shaded diamond centre

indicates a cancellation of one force by another. The remaining effective stresses are shown in Fig. 6 (b). The neutral axis is therefore the point where the tensile and compressive stresses are definitely separated. In a beam with a finite breadth, for we have been considering only a thin vertical slice, the neutral axis becomes the neutral plane. The use of the word neutral implies a point, place or plane where there is a definite neutralization of opposite forces, or stresses. The force acting along the neutral plane is therefore horizontal shear, for the forces acting on either side are opposite in character and equal in magnitude.

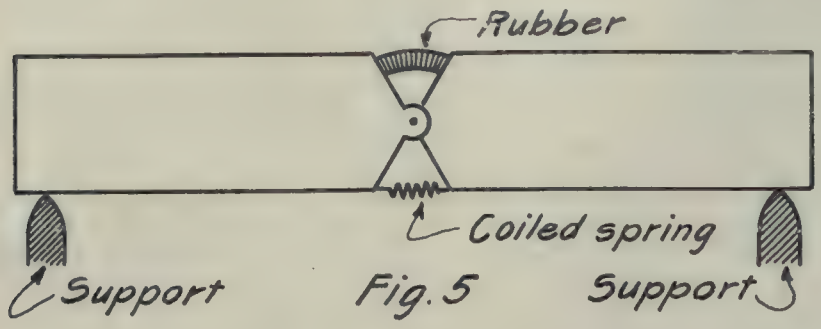


Fig. 5

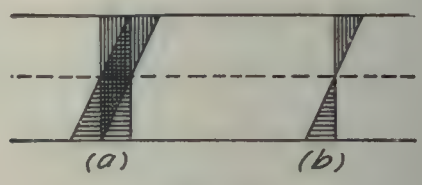


Fig. 6

The principal of the lever is evident. The length of the lever arm is the distance between centers of gravity of the opposite forces and the fulcrum is situated in the neutral plane.

In a reinforced concrete beam steel is placed near the lower edge to take all the tension, for, roughly speaking, concrete is ten times stronger in compression than in tension. In a plain concrete beam the neutral plane will be very high because the tensile and compressive forces must be equal. The tensile stress will be low and the compressive stress will be high, but the lever arm is a constant. The relative volumes of the two force wedges will be approximately as 10 is to 1.

When steel reinforcement is used the area required is computed on the assumption that it will carry all the tension and the value of the concrete in tension below the neutral axis is neglected. The tensile stress therefore does not vary from zero at the neutral axis to a maximum, but the compressive stress above the neutral axis does so vary.

The ratio of deformation between concrete and steel prevents the consideration of the value of concrete in tension. Experiments have shown that when steel embedded in concrete is stressed in tension to an amount practically equal to the tensile strength of an area of concrete equal to the steel area, multiplied by the ratio of deformation, the concrete cracks. The tensile strength per square inch in the concrete at the level of the steel $= f_s/n$, in which f_s = unit tensile steel stress.

These cracks are vertical and fairly uniformly spaced. They probably extend as far into the beam as the neutral axis when the beam is on the point of failure. If the beam is well made and the bond of the concrete to the steel is good the cracks are so small, because numerous, that there is no danger of the entrance of moisture in large enough amounts to cause rusting of the steel. It is therefore possible to use steel with a very high stress, for the ratio of deformation is not a stress ratio as in the case of columns carrying direct compressive stress. In a column a high compressive stress on the concrete may strip it from the steel. In beams a high tensile stress in the concrete merely cracks it and the concrete between the cracks clings to the steel and protects it from corrosion. The vertical tension cracks in beams are shown in Fig. 7.

The ratio of deformation plays an important part in determining the location of the neutral axis in concrete beams. In the Chicago Building Code the following values are used as a result of experiments:

Mixture	Ultimate Compressive Strength Per Sq. In.	Ratio of Deformation
1:1:2	2,900	10
1:1½:3	2,400	12
1:2:4	2,000	15
1:2½:5	1,750	18
1:3:7	1,500	20

The allowable safe unit stress per square inch is thirty-five hundredths of the ultimate strength in compression.

In reinforced concrete we have two materials with widely differing unit stresses. The letter f is used to denote the unit stress per square inch, usually termed the "Fiber Stress." The unit steel stress is f_s and the unit concrete stress is f_c. The stress ratio f_s/f_c is denoted by the letter m (meaning "measure"). The ratio of deformation is denoted by the letter n (meaning "number"), for it is an arbitrary number which is approximately correct.

Fig. 8 is a graphical representation of the effect n and m have on the location of the neutral plane in a reinforced concrete beam. On a piece of quadrille ruled paper plot the depth from the top of the beam to the centre of gravity of the steel by setting off ten divisions. Set off on the same scale the ratio of stresses (m) and the ratio of deformation (n) as shown. The depth to the neutral axis, k, may then be scaled. The exact value is $k = \frac{n}{n+m}$.

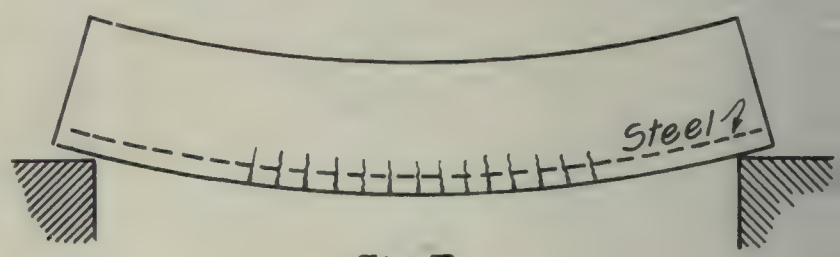


Fig. 7

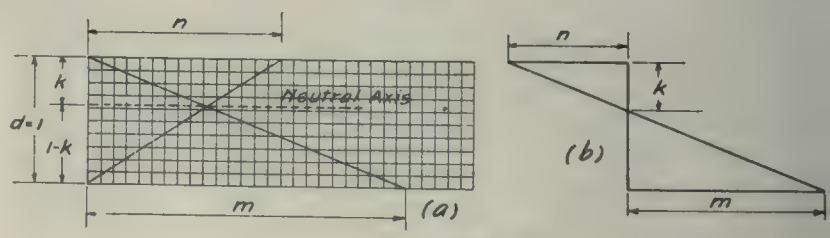


Fig. 8

Example. What is the value of k when $f_s = 16{,}000$ lbs. per square inch and $f_c = 650$ lbs. per square inch?

$$n = 15$$

$$m = \frac{16000}{650} = 24.62$$

$$k = \frac{n}{n+m} = \frac{15}{15+24.62} = 0.378\ d$$

Fig. 9 shows the force triangle of the concrete in compression and the steel in tension. To find the ratio of steel, proceed as follows:

The total amount of compressive force is found by obtaining the area of the force triangle. The height is kd and the average stress is $f_c/2$. The compression $= kdf_c/2$. We use kd for the depth, d, has a definite value and k is a percentage of d. The moment arm, the lever, has a length $= d - kd/3$ or jd. $(j = 1 - k/3)$. The total compressive force in a thin slice, $C = f_c/2 \times kdjd = f_c/2 \times kjd^2$.

The tensile force $T = f_s Ajd$, in which $A =$ area of steel in square inches. The steel ratio $= A/bd = p$, so it is necessary to introduce the breadth b, into the expression.

We now have $C = f_c/2 \times kjbd^2$ and $T = f_s pjbd^2$ then $f_c k/2 = f_s p$, provided $C = T$, which is the case for a beam with "balanced" reinforcement.

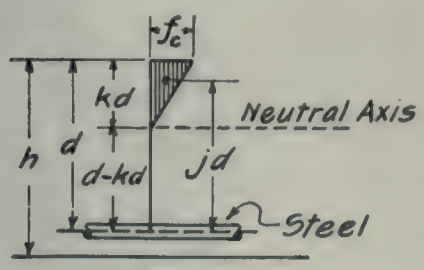


Fig. 9

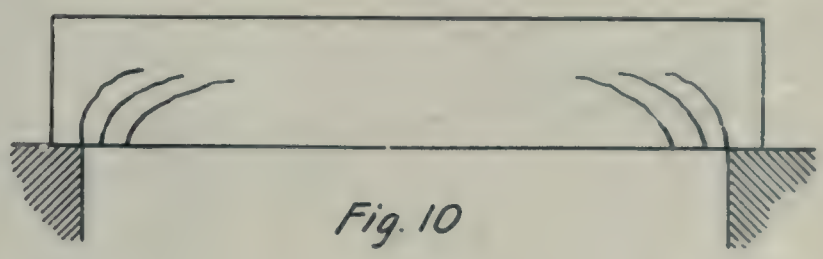


Fig. 10

Assigning values, $650/2 \times 0.378 = 16000p$ and

$$p = \frac{325 \times .378}{16000} = 0.00767$$

$p \times 100 =$ per cent of steel $= 0.767$ (0.77%).

By formula $p = k/2m$.

Assume a beam 6 inches wide with depth to the centre of the steel $= 9$ ins. What is the resisting moment?

$C = 325 \times 0.378 \times 0.874 \times 6 \times 9^2 = 52{,}242$ in.-lb.

What area of steel will be required?

$A = bdp = 6 \times 9 \times 0.0077 = 0.42$ sq. in.

Check the steel:

$T = f_s Ajd = 16000 \times 0.42 \times 0.874 \times 9 = 52{,}859$ in.-lb.

The greater resisting moment in tension is due to having used 0.42 sq. in. of steel, the exact area being 0.4158 sq. in. The area of steel used is governed by the commercial sizes of bars and rods, or the expanded metal or wire fabric used. The actual steel area used will usually be greater than the theoretical area necessary.

Every reinforced concrete beam has two moments of resistance; one determined by the concrete, the other by the steel. The lesser of the two is the resisting moment which determines the actual strength. In designing slabs a width of one foot is taken, for a slab is merely a wide and shallow beam assumed to be made up of a number of beams each 12 inches wide.

R is a moment factor. For the concrete $R = f_c kj/2$. For the steel $R = f_s pj$. Then the bending moment $M = Rbd^2$; $b = M/Rd^2$; $d = \sqrt{M/Rb}$.

To design a beam select stresses for the steel and concrete and find R. The value of M is the bending moment which is equal to, or is less than, the resisting moment. Assume a breadth and solve for the depth, or assume a depth and solve for the breadth. T beams are beams in which the floor slab is considered to be a part of the beam and carries the compression. The breadth, b, is the width in the floor slab and the stem below the slab must be wide enough to contain the reinforcement. The width necessary must include space between the bars and on each side to furnish bond and shearing strength.

Below the steel there must be a covering of concrete not less than the thickness of the steel, with a minimum thickness of one-half inch, this being for bond and fire protection. In all building ordinances minimum coverings of concrete are specified; as for example, one-half inch for slabs and one and one-half inches for beams, girders, and columns.

Shear

Fig. 10 shows a beam with typical shear cracks. A beam may fail by crushing of the concrete in the top, by the stretching or slipping of the steel or by shear, which is manifested by the appearance of shearing cracks. These cracks are an indication of tension in the concrete and stirrups are used to prevent shearing (diagonal tension) failures.

Fig. 11 (a) shows a uniformly loaded beam resting freely on two supports. At (b) is shown the shear diagram. The vertical shear at either end is equal to one-half the load and is zero at the point of maximum bending moment. The vertical depth, measured in pounds, of the shear diagram at any point is a sum-curve of the loading to that point.

The bending moment at any point is the area of the shear diagram between that point and the support. The vertical dimension is in pounds. The horizontal dimension is in feet when the result is foot pounds and in inches when the result is inch pounds. The bending moment at any section, such as y.....y is the sum curve of the shear at that section.

The shear being tension increases from the top and bottom skin to a maximum at the neutral axis where the bending stress changes from tension to compression and from compression to tension. In a beam of homogeneous material with a uniform cross section the shear is the same above and below the neutral plane at equal distances from this plane. This distribution of horizontal shear is found in a reinforced concrete beam above the neutral plane. Below the neutral plane the shear is constant, for all the tension is carried by the steel. The unit value of the shear at all depths from the neutral axis to the centre of gravity of the steel is determined by the expression, $v = V/jbd$ in which $d =$ depth from top of beam to centre of gravity of the steel.

In Fig. 12 is given an illustration of horizontal shear. Several planks laid loosely on end supports bend under load and the slipping of one plank past the adjoining plank is a horizontal movement. This is shown in Fig. 12a. Spike, or bolt, the planks together as shown in Fig. 12b and the slipping cannot occur. The spikes or bolts represent with fair accuracy the stirrups used in reinforced concrete beams. The shear being a maximum at the ends where the bending moment is a minimum, the fastenings are closer together than

nearer the middle of the span where the shear is a minimum and the bending moment is a maximum.

By reference to Fig. 11b it is seen that vertical shear exists at all points on a beam. We have seen that horizontal shear also exists at all points on a beam. Along the neutral plane it is equal to the maximum end vertical shear. Very

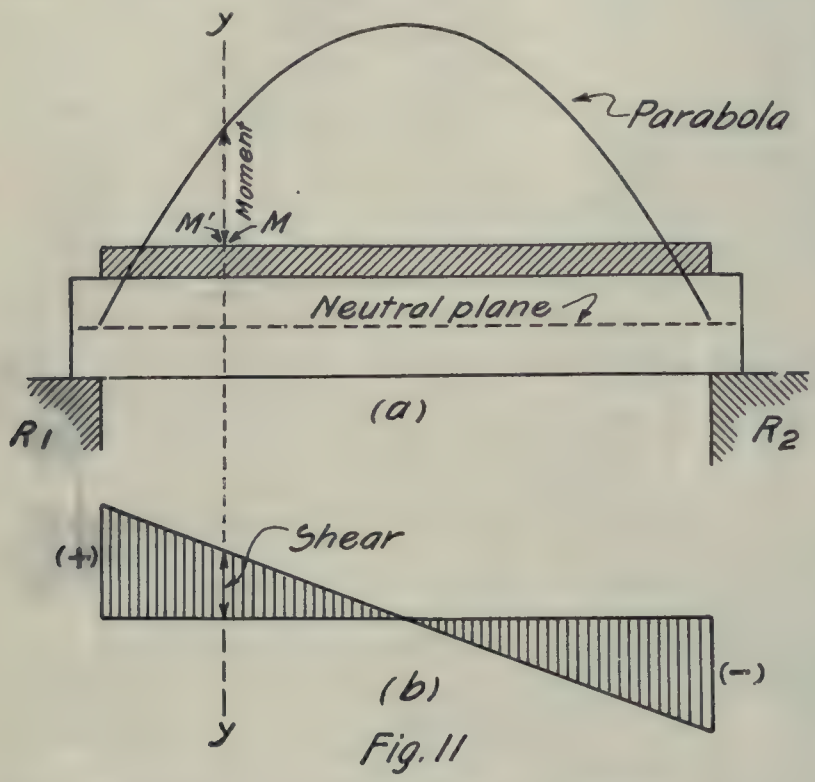


Fig. 11

thin horizontal slices, like the planks in Fig. 12, are assumed for the purposes of computation.

The resultant, according to the parallelogram of forces, is a diagonal tension, which causes the cracks shown in Fig. 10.

In designing reinforced slabs, beams and girders the resisting moment must be equal to or greater than the bending moment. When this is fixed the beam must be tested for shearing strength, and if it is found to be deficient in this particular, steel in the form of stirrups must be provided or the size of the beam be increased. The unit shearing stress v should not exceed 40 lbs. per square inch for the concrete alone, nor exceed a total of 120 lbs. per square inch when stirrups are used.

Bond

Experiments have shown that 70 lbs. per square inch is a safe allowance for bond in order that the steel and concrete may act together. The coefficient of expansion of the two materials is practically the same, so we need not fear a separation under extreme variations in temperature.

Assuming the two materials to act together and the safe bond stress is 70 lbs. per square inch, what length of embedment is necessary for a bar one-inch square stressed 16,000 lbs. per square inch?

The one-inch square bar has four square inches of surface for each inch of length.

$16{,}000/(4\times70)=57.142$ in. embedment required.

Four ½-inch square bars have the same area as one 1-inch square bar but the surface $= 4\ (4\times\frac{1}{2})=8$ square inches and the length of embedment $= 16{,}000/(8\times70)=28.57$ in.

When a large bar having sufficient area to carry the tension is found to be deficient in bonding area, smaller bars may be used. The stress is the maximum tensile stress in the reinforcement at the point of maximum bending moment, and the reinforcement each side of this point must be long enough for bond.

Bending Up Steel

The bending moment decreases toward the supports and when a number of bars are used they may gradually be decreased in number, always allowing not less than two to go the full length in the bottom. The other bars are turned up a short distance past the point where they are no longer needed for direct tension, being carried to within an inch of the top of the beam on an angle of 45 degrees or less, and thence horizontally to the supports. Half the steel area may thus be bent up at 0.23 of the span from the support, one-half the remainder at 0.15 of the span and one-half of the remainder at 0.10 of the span. These rules are closely approximate and apply only to uniformly loaded beams. Exact rules are given in text books. Bent up steel assists in reinforcing the web or body of the beam and thus strengthens the beam against failure by shear.

Stirrups

Stirrups should be fastened to the tension steel, not merely looped around it. They should extend far enough above the neutral axis to develop bond. The stress in the stirrups is tension and it is equal to the tension in the concrete multiplied by the ratio of deformation at the instant the concrete cracks, when the whole stress is immediately taken by the steel. The stress used for stirrups should not exceed 75 per cent. of the stress in the tension reinforcement.

The stirrups should be equal in area and the intervals should increase by increments of 50 per cent. or logarithmically, the greatest interval being equal to d. The area of steel in the bent up bars should be neglected when it is more than 0.15L from the supports, for the maximum shear is at the edge of the support at either end. When four stirrups are used at each end, the first will be ¼d from the support; the second ½d from the first; the third ¾d from the second and the fourth d from the third.

Reinforcing a Circular Tank

In a round tank the only stress is tension, being equal to wd/2 in which w = weight (pressure); d = diameter.

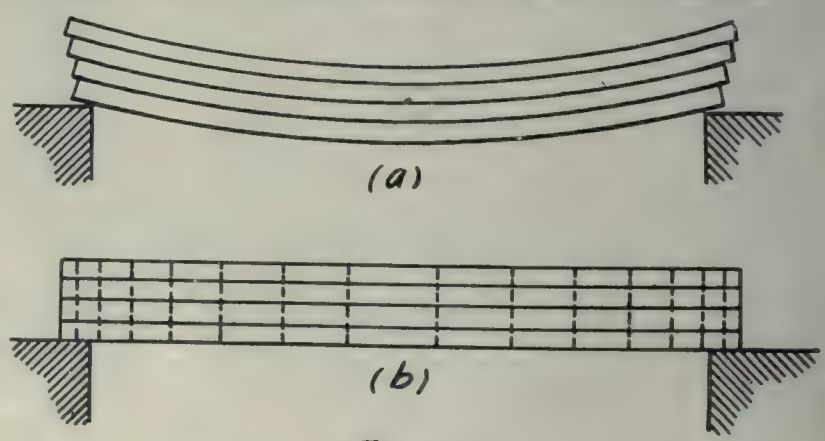


Fig. 12

The tension is figured for strips one foot wide, the weight used being the weight of the liquid at the depth of the strip. The weight of one cubic foot of water being 62.5 lbs., w at the depth of 10 ft. is 625 lbs. At 15 feet the weight is 937.5 lbs.

The stress to be used in the steel cannot exceed f_s/n, or large cracks will open. The concrete shell should be de-

signed to carry all the stress with an assumed safe unit tensile stress. Steel should be used to carry all the tensile stress. This combination fixes the unit stress in the steel as equal to nf_c until something causes the tank wall to crack, after which all the tension is carried by the steel with the assumed fiber stress, f_s.

Owing to the difficulties encountered in construction no tank wall should have a thickness of less than six inches, regardless of the theoretical thickness found by computation.

Example: Give the proper thickness of wall and amount of steel required for a circular tank 20 feet in diameter at a depth of 14 feet, using a 1:2:3 concrete.

$$T = \frac{wd}{2} = \frac{14 \times 62.5 \times 20}{2} = 8,750 \text{ lbs.}$$

Use a tensile stress of 12,000 lbs. per square inch in the steel in order to care for possible mistakes in connecting ends of bars. Clamps should not be used. The best method is to have the ends of the bars overlap a length of not less than 40 times the thickness. The overlapping ends should not be in contact, but should be separated to leave a space of about twice the thickness of the bars so the concrete may surround the steel.

$A_s = 8750/12000 = 0.729$ square inches (area of steel).

Use three ½-inch square bars, giving an area of 0.75 sq. in.

A safe tensile stress for well made 1:2:3 concrete is 175 lbs. per square inch. Area of concrete = 8750/175 = 50 square inches. The theoretical thickness of the wall is 50/12 = 4.166 in., for the strip is 12 inches wide. The thickness, for reason given, should be not less than 6 inches, so the actual area will be 72 square inches.

The area of the concrete is 72 square inches minus area of steel = 72 — 0.75 = 71.25 sq. in.

The ratio of deformation for 1:2:3 concrete is 12, so the steel is equivalent to a concrete area of 12 × 0.75 = 9 sq. in.

Adding: 71.25 + 9 = 80.25 sq. in.

The average stress is 8750 ÷ 72 = 121.53 lb. per sq. in., and the stress on the concrete is 8750 ÷ 80.25 = 109.03 lb. per sq. in.

The stress in the steel, when both materials are carrying tension, is 12 × 109.03 = 1308.36 lb. per sq. in.

If, for any reason, the concrete cracks the steel will carry all the tension with a stress of 12,000 lbs. per square inch. Cracks may occur where an occasional poorly mixed batch of concrete was deposited; where construction joints are defective; where forms were removed too roughly; through ice pressure; by reason of excessive temperature changes; frequent and sudden changes in pressure due to quick filling or emptying of water; through defective foundations. When the steel stress is not permitted to exceed 12,000 lbs. per square inch the only effect of cracking will be to throw the entire tension on the steel and the cracks will not be large enough to cause corrosion or leakage.

Personals

Mr. J. K. Scammell, C.E., a consulting engineer of St. John, N.B., has volunteered for overseas service. During his absence his business is being carried on by a graduate engineer who himself is prevented from joining the colors by physical unfitness.

Various changes recently made in the staff of the Dominion Steel Corporation at Sydney, N. S., include the following: the appointment of Mr. W. H. Bishop, of the Bethlehem Steel Company, as steel expert; the promotion of H. E. Rice to the position of assistant general superintendent, his jurisdiction extending over the various mills of the steel company, and the promotion of Geo. D. Macdougall, former mechanical superintendent of the steel works, to the position of chief engineer.

Mainly Constructional

East and West—From Coast to Coast

The Monarch Land Building Company, Limited, has been incorporated with a capital of $40,000, head office at Windsor, Ont.

It is said that the building record for Galt, Ont., this year, will be the highest in the history of the city. In no previous year have so many factory additions been made as this season.

The Supreme Court of Canada has upheld the decision of the Manitoba Court which found Thomas Kelly, the Winnipeg contractor, guilty of the charges against him, which include fraud, conspiracy, theft, and embezzlement.

It is interesting to note that Messrs. Foley, Welch & Stewart, the well-known western railway contractors, have secured a contract for 3,000 miles of new railroad in Eastern Russia. It is understood they already have their men and engineers on the ground.

During the month of October this year, building permits were issued in Chatham, Ont., amounting to $18,125, an increase of $5,750 over the same month last year. The total for the ten months of the year is $275,199, as compared with $181,189 during the corresponding period last year.

Evidence of the satisfaction given by the central heating plant system in the city of Brandon, Man., is shown by its increasing popularity, and the Electric Light Company are receiving a great many orders this year for installations on this branch of their service.

An order winding up Robertson & Sherris, stonecutters, was recently made at Osgoode Hall, Toronto, on the petition of James Robertson, president, creditor for $200 on a promissory note. The company was incorporated with a nominal capital of $20,000.

It is stated that at the present time there is considerable difficulty experienced in obtaining housing accommodation for newcomers in the city of Chatham, Ont., and it is expected that there will be great real-estate activity in the near future.

Mr. W. A. McLean, Deputy Minister of Highways for the Province of Ontario, reports that Stormont, Dundas and Glengarry have fallen in line with the twenty other counties which have adopted the Good Roads' system. There are still fourteen counties which have not taken advantage of the Ontario Highways' Act.

Construction operations on Hudson Bay Railway and Port Nelson Terminals have closed down for the year. Rails are laid as far as Kettle Rapids, as planned for the season. This is 330 miles north of The Pas. During the winter two bridges over the Nelson River will be completed and track-laying will be finished to Port Nelson early next summer.

October's building permits in the city of St. John, N.B., total $83,100, as compared with $36,350 in the same month last year. The figures for the ten months of the year are $447,350, as compared with $283,150 during the corresponding period last year. A $70,000 school helped to increase last month's total considerably.

The Galt Brass Company, Galt, Ont., propose to erect two new buildings which will double their capacity. Architect J. Evans has prepared plans for two modern structures —one, 50 ft. x 80 ft. in dimensions, two storeys with basement, and the other, 40 ft. x 60 ft., one storey. Both buildings will be constructed of brick and concrete and will be modern in every respect.

The Good Roads' movement in Ontario County, Ont., continues to spread, and branches have now been formed for the townships of East and West Whitby, Reach and Scugog, and for the village of Port Perry. It is probable that at the November session of the county council a deputation will urge the adoption of a county system of good roads.

It is stated that the building operations this season in Walkerville, Ont., have set a new record for that town and that by the end of the year the figures will have more than doubled those of 1915. The building values by months up to the end of October are as follows: January, $6,000; February, $5,500; March, $16,500; April, $40,700; May, $33,825; June, $36,100; July, $34,725; August, $17,600; September, $35,850; October, $9,525.

No. 151 Local of the Painters' and Decorators' Union recently met in the Labor Temple, Toronto, when they decided to notify the civic, provincial and federal authorities that after January 1, 1917, the rate of wages for men of their craft would be 45 cents an hour. At the beginning of next year an organizer will be employed to more thoroughly organize the non-union painters and decorators in the city of Toronto.

The building permits issued in the city of Vancouver during the month of October number 41 and amount to $394,085. Offices and stores, valued at $300,000, constitute the greatest part of the month's building operations. The total for the ten months of the year is 350 permits, valued at $2,025,829. The above figures compare with 36 permits issued in October, 1915, value $214,455, and 551 permits which were issued during the first ten months of 1915, at a value of $1,552,599.

The members of the Engineers' Club at Thorold, Ont., were recently addressed by Mr. Brockbank, of the Exolon Abrasive Works, on the subject of "High temperature reactions." Mr. Brockbank described the methods and processes used in the Exolon works. With the aid of samples of the raw materials, products and by-products, he illustrated the various operations involved in the manufacture of abrasive materials. The electric furnaces, developing temperatures up to 2,025 degrees centigrade, were also described in detail.

A meeting was recently held at Cobourg, Ont., in the Counties Council chamber, to organize the district for the purpose of effecting the improvement of the Kingston Road. The municipalities east of Kingston had previously appointed a committee to take up this matter, and at this meeting another committee of 25 members was named to act in conjunction. The object is to ask the Ontario Government to take over the Kingston Road and make it a provincial highway.

The members of the Good Roads' Committee of Kent County, Ont., have drafted a schedule and bylaw of the roads which it is proposed to rebuild, for presentation to the county council at the December sessions, with a recommendation that the Ontario Government's scheme of good roads be adopted. The scheme which the council will in all probability undertake is a very extensive one and will entail a heavy expenditure. It will result, however, in the building of some of the best roads in Ontario, affecting all of the principal thoroughfares in Kent.

It is stated that New Zealand proposes to adopt concrete as a road-building material. The U. S. Consul-General at Auckland, has, it is said, reported to the state department that the local and national authorities of New Zealand are studying the good roads' problem, as they have found the up-keep of stone roads very expensive. They estimate that a mile of 12-foot concrete road could be built for $2,000 more than a mile of ordinary stone road and that there would be a saving in up-keep of at least $1,200 a mile in the first five years, while at the end of ten years there would be a saving of $7,000 or $8,000.

During the month of October the Civic Labor Bureau, Toronto, found employment for 569 men and 33 boys, while during the previous month 566 secured employment. An outstanding feature of the placing of men is that a great demand has developed for outside tradesmen, and the call from builders and contractors has been heavy, owing to the fact that frost may set in at any time now and the contractors are anxious to finish the work commenced. It is said that the majority of foreigners applying for work are seeking factory jobs and not the outside work, though a large number of them are merely unskilled laborers. A great demand is being made for machinists in the larger establishments in Toronto.

The Bricklayers' Union held a very largely attended meeting in the Labor Temple, Toronto, recently. Mr. John Vick, the business secretary, reported that negotiations with the employers with reference to the voluntary increase of wages till the end of the year and the agreement for next year were progressing satisfactorily and that there would be something to present to the organization at the next meeting. It was decided to send one delegate to the Provincial Conference of Bricklayers, Stonemasons, and Plasterers, which will be held in the near future. It was also decided that the union would not pay the extra per capita tax to the Building Trades Council for the purpose of appointing a business agent.

W. W. Van Every, who on October 2 was appointed manager of the city water and light department of Sault Ste. Marie, Ont., where he formerly held the position of city engineer, has submitted a report to the council regarding the state of affairs which exists in the department of which he is now in charge. His report states that generally speaking it is in a very unsatisfactory state and that the physical plants, both water and light, are in poor repair. In the electrical department a considerable amount of the apparatus should have been replaced, or extensively repaired when the city acquired the system; in the waterworks a similar condition exists. The intakes are in such a position that there is every possibility that the water may be entirely cut off due to ice troubles during the winter. Mr. Van Every states that the critical condition of the city's pumping plant cannot be too strongly emphasized. Attention is also drawn to the storage facilities for piping, fittings, repair wagons, etc., which apparently are in a bad condition.

Obituary

News has been received by Richard Reid, Agent-General of Ontario in England, that his son, John Stanley Reid, has been killed while serving at the front with the Canadian Mounted Rifles. Mr. Reid was 27 years of age and had formerly been on the engineering staff of MacLeod, Alta.

The death occurred recently of Jacob W. Steeves, a prominent resident of Elgin, Albert County, N.B., at the age of 84 years. The late Mr. Steeves was a well-known railway contractor, having built that portion of the Intercolonial Railway running through Folleigh Lake, N.S., as well as many sections of branch lines in New Brunswick and several important railway lines in the State of Maine.

Mr. Leon Maguire, who with his father, Mr. John Maguire, has carried on a successful contracting business in the city of Toronto, where they are well known to the trade, fell a victim to typhoid fever recently and died within a short time. His father also was taken with the same disease, but is recovering. Mr. Leon Maguire was 30 years of age. He had recently been residing in St. Catharines, where he was carrying on some contract work.

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Industrial Research and Its Relation to Commercial Supremacy

THE present war is a mighty effort by Germany to gain not only a military, but also a commercial, supremacy. To-day, it is true, the eyes of the whole world are fixed on the struggle which for the moment is concentrated on military affairs. But this is, comparatively speaking, a passing condition. To-morrow the military struggle will end and then the real and permanent business of the nations will begin—industrial war. No one doubts that our military enemies of to-day will be, in equal strength, our commercial enemies of to-morrow. No one doubts that the same qualities which make our enemies almost supernaturally formidable to-day in a military sense will lead them to contest every inch of commercial territory with the same craftiness, the same persistence, and, let us not forget, the same efficiency.

The craftiness of the enemy, however, we are now fully alive to, and, being forewarned, will also be forearmed. Persistence, too, is a quality that characterizes preeminently the British bulldog. But efficiency is a human product, of which, generally speaking, the German nation has been popularly credited with a monopoly. Yet it is on this one factor—efficiency, ever greater efficiency—that the outcome of the future struggle for commercial supremacy will, to a very considerable degree, depend.

Therefore, it is on this one basic factor that the British Empire and Canada, as an essential and highly valuable part of that empire, must concentrate; and, fortunately for us, efficiency is not bounded by geographical limits. We can have it, if not for the asking, at least for the taking, and we shall have little excuse if the coming struggle does not find us fully equipped and armed to the teeth.

And what is commercial efficiency? Surely it is the co-relation of all the factors that can in any way improve that efficiency. It is the co-operation of men and methods. It is the synchronizing of business, science, and government. It is the working together, for the common good of theory and practice, university and factory, professor and manager, encouraged, supported and guided by the ruling authority in the land. Scientific methods applied to practical problems—this is the weapon with which our enemies will meet us, and this is the weapon we must have accustomed ourselves to use in the most effective manner possible.

It is gratifying to note that the Canadian Government has recently moved in the matter, and in creating a committee of council and an honorary advisory committee have given formal recognition to the "urgent necessity of organizing, mobilizing, and encouraging the existing resources of industrial and scientific research in Canada, with the purpose of utilizing waste products, discovering new processes—mechanical, chemical, and metallurgical—and developing into useful adjuncts to industry and commerce the unused natural resources of Canada." In this they will have the hearty co-operation alike of the Canadian men of commerce and the university staffs—the latter of whom are in many cases eminently fitted by experience and training to assist in this development. Indeed, we may take as typical of the university attitude the recent utterances of Professor McLennan in his inaugural presidential address before the Royal Canadian Institute. Professor McLennan is, of course, known throughout the scientific world as a research enthusiast, and he has long advocated the establishment of research depots at strategic points in Canada, to which commercial men may bring their problems and discuss them with a trained research staff. Now that the war has forced the necessity for action on the attention of our Government, we hope they will not hesitate longer to make a move in this direction. In the meantime the public are slowly realizing actual conditions and adjusting their ideas afresh. To many of our readers no doubt the ideas expressed in Professor McLennan's address are entirely new, and, in part, we reproduce them on other pages of this issue. It is a question we earnestly commend to the careful study of every thoughtful Canadian, for, on whether or not we prepare to-day for the challenge to a commercial war that we are sure will be made to-morrow (indeed, if we can believe the reports, has already been made in elaborate German preparations for after-war trade) will depend very largely the benefits we shall derive as a nation from the awful sacrifices our brothers are now making on the battlefields of Europe.

Building Prosperity West and East

LOOKING back over the season which has just passed, and reviewing the building and constructional activities which have been carried on in our cities and towns from coast to coast, one cannot but be impressed with the fact that, despite the war, Canada is prospering, and that the prospects, even for the near future, are bright. It is particularly encouraging when we turn to the West, where the first shock of war seemed to bring its rapid constructional development to a standstill and to deaden trade generally. In the older provinces in the East, where growth and development were not quite so noticeable, and where big orders for munitions and war supplies soon provided as much work as could be handled with the facilities available, the declaration of war had not such a startling effect. Now, however, before the end of the war is even in sight, we find that the West is again picking up with characteristic rapidity; for the condition of the building trade may be taken as a fairly accurate indicator of the general trend of business, and the building records show that, during the later part of the season especially, the amount of the building permits issued is far in advance of the values for the corresponding period last year. The total of the permits issued in October in our 17 principal Western cities is $872,225, an increase of considerably more than 100 per cent. over the same month in 1915, when the figure was $332,277. The figures for September are almost equally encouraging, while for the first ten months of 1916 the total is $6,447,722, as compared with $5,025,351 last year in the same period.

The building permits issued in the East also compare favorably with those of last year. Figures compiled for the 28 principal cities in our Eastern provinces show that the value of the permits for the month of October is $3,077,331, as against $2,128,019 in October, 1915. The total for the first ten months of the year in these cities is $24,117,291, compared with $21,669,189 during the corresponding period last year.

A comparison of the complete figures for the 45 cities during the month of October shows an increase of nearly $1,500,000 over the same month last year, the amounts being $3,949,556, and $2,460,296 respectively, while the grand total for the first ten months of this year is $30,565,013, as compared with $26,694,540 during the corresponding period in 1915.

In municipal and public works, also, a revival of pre-war activity is becoming apparent in the Canadian West, and towns are undertaking or arranging for vast improvements, which indicate that there will be a free circulation of money during the coming year, and that it will be a prosperous one for those whose business is in the constructional line. For example, a great many good-sized Western towns are still without electric lighting, and the agitation is general in these places for this convenience. Oxbow, Sask., carried an electric light debenture by-law by 9 to 1, and the plant will be in operation before the end of the year. Melita, Man., is working on a plan for an electric lighting system, and more than a dozen other towns are discussing the question, with good prospects of going ahead with the construction of the plants during next year. The Winnipeg city hall, on which construction was postponed indefinitely because of the tightness of money and some difference of opinion as regards the site, is now again coming before the public attention, as the present building is not in keeping with the progress of the city, and there seems a possibility that the new structure, for which plans were prepared at great expense, may be commenced during 1917. A new project is also being considered in the town of Souris, Man., in connection with the heating of the business portion of the community. It is proposed to accomplish this from a central gas plant which has already been installed, working somewhat along the same lines as Brandon, Man., where a central heating plant has been operated for some years with considerable success in the business section of the city. The main obstacle to the plan is the high cost of construction, but with the growing scarcity of wood and the increase in cost of all kinds of fuel it is possible that Souris and many other points will be driven to the early installation of plants which will heat the more closely populated parts of the towns, and the matter is being given very general consideration.

It is hardly necessary to mention such huge undertakings as the work on the Winnipeg aqueduct and the Manitoba parliament buildings, the harbor development at Vancouver, New Westminster, and Victoria, while in the smaller cities public works of lesser importance are being carried out or are contemplated, including waterworks and sewage improvements, hospitals, churches, and a large number of schools. Private interests are erecting many warehouses, factories, and office buildings, and it is safe to say that such corporations as the T. Eaton Company, Ltd., who are expending some $600,000 on their warehouse in Winnipeg —the first unit of a store which is to cost some five or six millions—and the Imperial Oil Company, whose refinery at Regina is costing about $1,000,000, would not invest such large sums of money in the Canadian West had they not reasonable assurance of a tremendous development in the near future.

Regina Branch C.S.C.E.

At a recent regular meeting of the Regina branch of the Canadian Society of Civil Engineers the main discussion referred to the recent appointment of the "commission of enquiry into railways and transportation" and the action of this commission in choosing American engineers to organize their valuation work. In the first instance, the Dominion Government was sharply criticized for appointing such a commission, which to a large extent will influence the whole financial future of Canada, and in which a number of important engineering questions will occur, without giving the engineering profession of the Dominion a representation on this commission. In the second place, the act of this commission in appointing alien engineers to such prominent positions was discussed, but no final decision was reached. This matter was left with the executive of the branch, with power to prepare a resolution in this respect and forward a copy of same to every member of the Federal Government for the Province of Saskatchewan.

Building with Cement Gun

Concrete reservoirs have recently been built without the use of form work by using the cement gun. A light structural steel frame of angles and bars is erected, with the required amount of reinforcing bars securely fastened to the frame. A heavy triangular wire mesh is placed over this reinforcement to hold the concrete in place while setting, and incidentally to serve as additional reinforcement. Heavy canvas ducking is stretched over the outside of the frame, and upon this, from the inside, a coating of concrete is applied with the cement gun. After allowing sufficient time for this coating to set, the canvas is removed and additional layers of concrete applied from both the exterior

and interior until the walls have acquired the desired thickness. The roof or cover may be formed in the same manner. One feature of this method is the ability of fashioning a variety of ornamental cornices. Successful results depend largely upon the skill of the operator. One advantage claimed for this type of construction is the reduced cost due to the elimination of form-work. It also produces a very dense concrete and a very close structure, thus obviating the need of waterproofing treatment.

A Town Planning Act

A conference on town planning for the Province of Quebec, called by the Commission of Conservation, was convened for Monday, November 20, at the Windsor Hotel, Montreal. The object of the conference, as set out in the circular, was for the purpose of "considering the desirability of presenting to the Legislative Assembly of Quebec, during the current session, a petition in favor of the passing of a town planning act for the province. The need for such legislation is urgent owing to the necessity for greater economy and more scientific methods being applied to the development of land for building purposes and owing to the need for greater conservation of municipal resources. Resolutions have already been passed in favor of it in other parts of the province. Town planning acts are in force in Nova Scotia, New Brunswick, Manitoba, and Alberta, and are being considered in other provinces." Invitations were issued to various local bodies, including the Builders' Exchange.

Manitoba Branch C.S.C.E.

On the evening of Nov. 2nd Mr. S. Bylander addressed the Manitoba branch of the Canadian Society of Civil Engineers on the subject "Shop Details of Steelwork for Buildings." The speaker drew upon his own experience and methods, discussing the subject under the following heads:

1. American methods, as introduced into England many years ago.
2. Old English methods.
3. Modern English methods.

Mr. Bylander explained quite fully his methods of detailing steelwork for fabrication, which are very similar to those practised by structural engineers in Canada. Some phases of the paper—for example, his methods of obtaining dimensions of skew members—were of special interest to anyone engaged in structural work. At the short business meeting the branch expressed its interest and voted hearty co-operation in the work of the Ladies' Auxiliary to the Canadian Engineers at the front.

Good Roads in Quebec Province

Further road legislation was foreshadowed in the address from the throne at the opening of the Quebec Legislature. The Gouin Government are strong supporters of good roads, and the extensive programme already carried out has met with almost universal approval. The Quebec-Montreal, Levis-Jackman, Sherbrooke-Derby line, and Montreal-Rouse's Point roads are completed. The work carried out at various points has been so extensive that the government will have to find more money, and a bill to raise a further loan will be introduced, in order to pay for the work and continue it on the same lines. The government, it is learned, intend to see that the roads are kept in repair. It has been pointed out that there is a tendency, even after good roads have been built, to allow them to get into disrepair. A bill which is to be submitted will provide methods by which the roads will be better maintained, it being understood that the government will only bear a portion of the cost of the upkeep. The repair of the road is just as important as the building, and it is useless to spend millions on highways if they are neglected in the matter of maintenance.

Hon. J. A. Tessier, Minister of Roads, in his report states that in the financial year of 1915-16, ended June 30, 1916, the department spent $4,000,700 for the construction of provincial and municipal routes, for the upkeep of earth roads, special work, small bridges, and administration expenses. The amount spent in 1916, the minister points out, will not be equalled in 1916-17, due to bad weather conditions. It was possible to procure laborers in certain parts of the province at $1.25 per day, and the average price did not exceed $1.75 per day per laborer. This year, however, the price of labor jumped, the prices paid being $2, $2.50, $2.75, and even $3 per day. It is remarked that municipalities doing work by day labor showed wisdom in suspending permanent works. One hundred and six miles of macadam and 74 miles of stone roads were constructed during the year.

Become Independent of Coal Supply

The scarcity of coal which Canada in general is experiencing is a good argument in favor of manufacturers and contractors taking steps to make themselves as independent as possible of the coal supply by installing electric appliances. The opinion has been expressed that the United States will, sooner or later, prohibit the export of coal, and the present shortage gives us a fair idea what we shall be up against should they suddenly decide to cease export to Canada. It is doubtless true tht our more progressive contractors have already discontinued the use of coal wherever possible, but there are still a number of isolated plants that could well be replaced by the more modern power. Especially where new expenditures have to be made it would seem to be the part of wisdom for manufacturers and contractors to remember that the United States as a source of coal supply for Canada is an uncertain quantity.

Joints in Concrete Roads

The theory has recently been advocated that for concrete roadways laid late in the season it is better to leave wider joints. Mr. A. N. Johnson, consulting highway engineer of Chicago, in the last issue of the Engineering Record, takes issue with this suggestion, claiming that too little is known about concrete roads to form correct conclusions. Mr. Johnson states that the Illinois Highway Department has this year constructed a number of stretches of road without any joints at all, and he raises the question whether in the long run there is not less expense in maintenance and less inconvenience to the public by leaving joints out altogether.

In the Interests of Public Health

At a recent convention at Quebec of the Public Health Services of the Province of Quebec, the Canadian Association for the Prevention of Tuberculosis and the Canadian Public Health Association, a resolution was passed that the plans of manufactures to be constructed or those already in existence that are to be rebuilt in whole or in part, should be approved beforehand by a Board of Inspection of industrial establishments.

New Marine Buildings at Victoria

THE coast line of British Columbia resembles in a very marked degree the fiords of Norway, and consists of innumerable sinuous inlets and indentations, to the extent of over 2,000 miles, from the 49th parallel to the Alaskan boundary, for which the Department of Marine, realizing the importance of the British Columbia coast, has provided, without a direct charge, all possible aids to navigation for ships frequenting these waters—a step in advance of other countries. Not only on the coast is this activity apparent, but there comes also within the purview of the Victoria agency the duty of providing for the necessary aids to inland waters, such as the Kootenay, Arrow, and Okanagan Lakes, all of which are amply supplied.

During the past few years the rapidly growing commerce has necessitated more adequate aids to navigation, and this department has not been laggard in anticipation of the requirements. Lighthouses, fog alarm stations, lighted buoys and beacons, and smaller structures, such as day marks and unlighted buoys, have been constructed wherever and whenever the necessity was demonstrated.

The lighthouses on this coast vary from small lights up to those of greatest strength, with powerful fog alarms in connection with the station, the most powerful lights being on the exposed Pacific, as all ocean-going traffic between American ports and Puget Sound, British Columbia, and the foreign ports of China, Japan, Australia, Russia, and elsewhere, have to pass these lights while using the Straits of Juan de Fuca, and the protection of maritime traffic, which is of the utmost importance, is receiving every consideration in keeping with the comprehensive policy now being enacted and carried out by the department

It is of interest to recall that in 1860 there were only two lights on the British Columbia coast, viz., Race Rocks and Fisgard, which still exist and are giving good service. These were built by the Imperial authorities, and from this small beginning the number has been increased yearly, until the various aids of all kinds and descriptions now number several hundred.

Foreseeing arising needs in the matter of increased accommodation when the Songhees Reserve at Victoria is opened for utilization the Government seized the opportunity of reserving an area with extensive water frontage—in all about 2½ acres—for the required depot, and without delay proceeded to grade the site and erect a serviceable wharf of a total length of 640 feet by 45 feet wide upon creosoted piles. This gives sufficient accommodation for mooring the steamers in service in connection with this agency. Upon completion of the wharf a contract was entered into with the well-known firm of Victoria contractors, Messrs. Parfitt Brothers, for the construction of a large buoy shed 40 feet by 80 feet, with provision for a 20-ton crane for the cleaning, painting, and recharging of buoys. Attached to this shed another one has been provided, 20 feet by 80 feet, with rooms for testing and repairing lamps, and for the installation of woodworking and other machines for making and repairing the different parts of fog alarm engines and other necessary work. In addition a blacksmith shop is being erected in which facilities will be provided to do all repair and upkeep work, it being the intention of the department to have all of this done on its own premises.

Fig. 1—Wharf completed on new depot site.

Fig. 2—General view of Marine Depot, Victoria, with lighthouse tender at wharf.

On the wharf there has also been provided a shed 30 feet by 148 feet for the handling of freight to and from the lighthouse tenders, and in the rear of this, upon the land, a storehouse 36 feet by 108 feet has been erected on a concrete foundation. This storehouse has a concrete floor, and the interior is suitably fitted with shelving and bins for supplies, which hitherto, for lack of storage space, have had to be purchased as required; also an office for the storekeeper in charge. A standard gauge railway track has been laid along the wharf, through the buoy shed and into the yard, having direct connection with the railways terminating on the adjoining property, which will facilitate the handling of the heavy buoys and material.

An adequate water service has been installed for washing out buoys, for steamers' use, fire protection, and general purposes. A surface drainage system has also been provided, as well as a landing stage for the use of small boats. The premises will be electrically lighted, and the machinery electrically driven, the necessary installation and connection for which is now being made with the British Columbia Electric Railway Company.

Building a Large Elevated Water-tower

Two hundred thousand gallons capacity—Supported on six-post steel tower—Details of plan and construction

THE Engineering News prints an interesting description, from a contractor's viewpoint, of an elevated water tank of 200,000 gallon capacity, with a six-post steel tower. The tower is 138 feet high from the concrete footing to the horizontal ring girder, and the height to the top of the tank is 172 feet 6 inches. The tank is 28 feet in diameter and 35 feet high in the cylindrical portion. It has a segmental

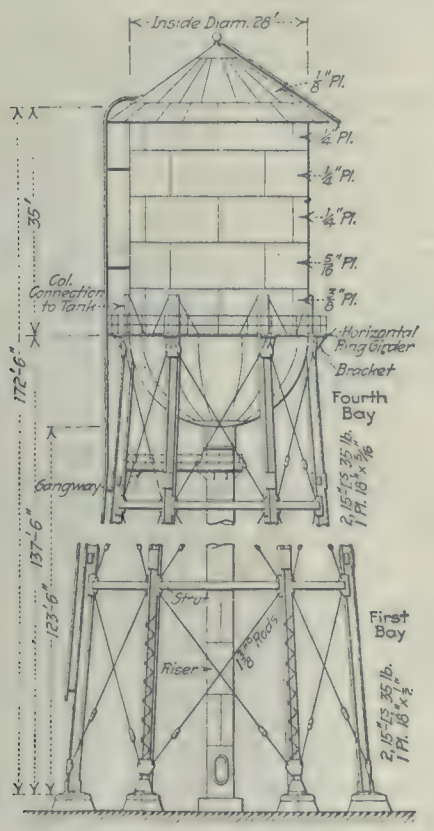


Fig. 1—Design of six-post water tower with 200,000 gal. tank.

bottom 14 feet deep, connected to a 48-inch riser pipe, and is covered by a conical steel roof.

The tower has a batter of 1 in 12, and is divided into four stories or bays by three courses of horizontal struts. The columns are of box section, each composed of two 15-inch side channels and an inner 18-inch cover plate, with double lacing on the outer side. They are made in four lengths of about 38 feet. The horizontal struts are pairs of channels with top and bottom lacing, except that at the end the channels are brought together and riveted to connection plates on the columns. Each panel has two adjustable diagonal tension rods, set up by turnbuckles and having welded loop ends fitted to 2-inch pins in the connection plates. The loops are double, straddling the plate and engaging both ends of the pins. The connection plates at the bottom are on the outside of the columns; the others are riveted to the sides—that is, to the webs of the channels.

Near the tops of the columns are outside brackets to carry the ring girder, above which the column is extended about 8 feet by four 6 x 4-inch angles, which are riveted to the bottom course of the side of the tank. Large reinforcing plates are placed between the backs of the columns and the tank plates.

The tank has five courses, 7 feet high, with each course outside of the next course below. The plates are 87 inches high and 15 feet long, with double riveting in the vertical seams and single riveting in the horizontal seams. All seams are made with lap joints. The thickness is 3/8 inch for the segmental bottom and the lowest course of plates, 5/16 inch for the second course, and 1/4 inch for the other courses. At the top are brackets carrying a circular channel supporting the 5-inch channels forming the rafters of the conical roof, which has 1/8-inch plates. The roof projects about 18 inches beyond the tank, and fits close against its upper

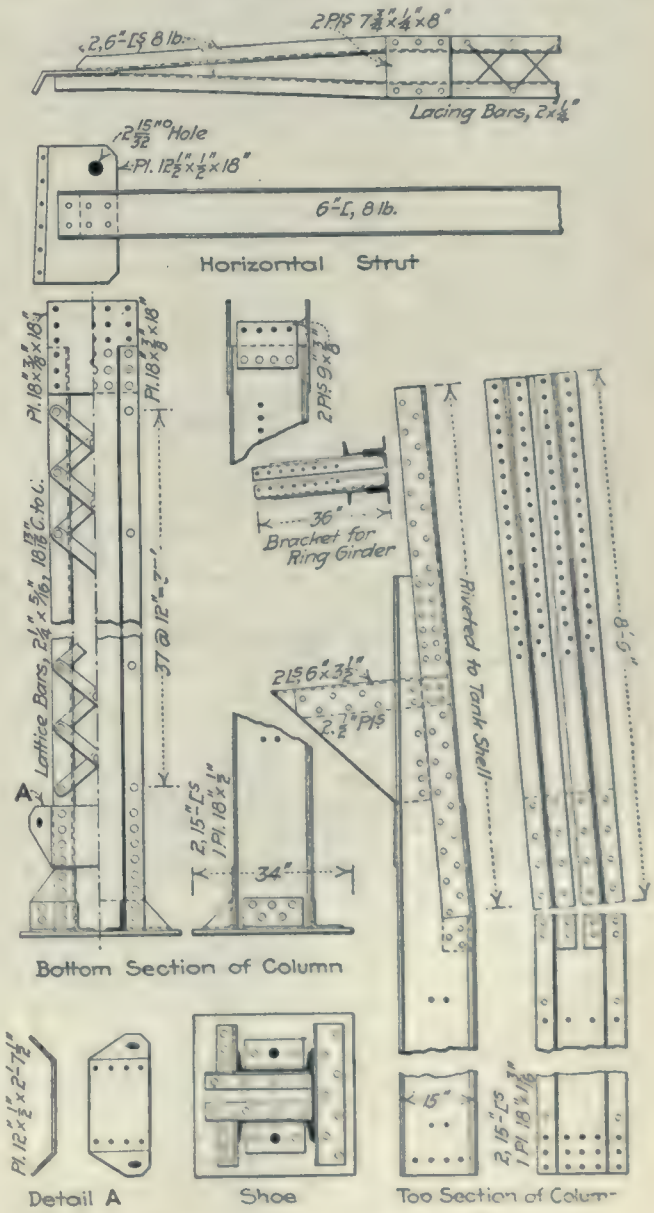


Fig. 2—Details of columns and struts of water tower.

edge, so that there are no openings by which birds can enter.

At the base of the cylindrical portion of the tank is a ring girder with a ¼-inch horizontal web plate 41 inches wide, having radial stiffeners on the under side. The inner flange is a single angle riveted to the tank shell; the outer flange is a 6-inch channel having its lower flange riveted on top of the web plate. The hand-railing around this girder consists of steel angle stanchions and top rail, with two diagonal bars in each panel.

About 18 inches below the top edge of the tank is an inside Z-bar ring that serves as a stiffener. On the cover is a swivel trolley for a painters' platform. The top of it is attached to the apex of the roof in such a manner as to allow it to revolve, and its lower end supported by means of a pair of 3½-inch flat-tired wheels between a pair of angles. This frame carries an outside bent plate having a hole for a clevis or stirrup, to which the tackle of the painters' platform is hooked. The overflow is a 3-inch pipe leading out through the top course of the tank and carried down one of the columns.

The 48-inch riser is of ¼-inch plates in 5½-feet courses, with single-riveted circular and vertical seams. At the top is a domed cover with a telescopic expansion-joint connection to the 12-inch pipe entering the tank. The bottom is flat, with a 12-inch opening for the pipe connection to the mains and a 6-inch opening for the pipe from the service pumps. A 10 x 16-inch manhole is provided in the lowest course of plate. With the large body of water in a riser of this size no frost-protection covering is needed.

To give access to the expansion joint there is a gangway from the column carrying the ladder to the riser pipe. Around the riser is a horizontal ring girder 4 feet wide, supported by brackets on the riser and forming a platform. The gangway has a floor plate 16¾ inches wide, resting on the bottom flanges of a pair of channels and stiffened by transverse angles

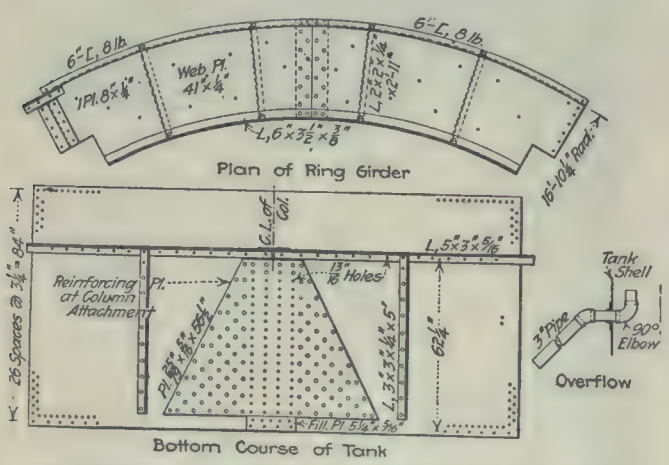


Fig. 3—Ring girder and bottom course of tank shell—showing reinforcing plate at column connection.

across the bottom of the plate and channels. Hand-rail stanchions are riveted to the backs of the channels. In this gangway, and in the ring girders and Z-bar stiffener, holes are made in the horizontal web plates to provide drainage.

The foundations consist of six heavy concrete footings or piers for the columns and a central pier for the 4-foot riser. The site is on a good gravel formation, and the pressure of the base of the piers upon the soil averages 2,770 pounds per square foot. The column piers are about 8½ feet high, 5 x 5 feet at the top, which is inclined so that the columns will be perpendicular to it. In each pier there are two 1⅞-inch anchor rods, with 2¾-inch upset ends. The anchor rods are inclined 1 in 12, and have the upper ends incased in 3-inch pipe sleeves 24 inches long, into which the rods are grouted after final adjustment. The size of the piers was not governed by the bearing, but was made to comply with a specified factor of safety of 1½ on uplift.

The central pier is 8 feet square and 9 feet deep. It has a chamber for the pipe connections and a valve on a 6-inch blowout pipe. The top of the pier, over the chamber, is reinforced with steel rods. There are 22½ cubic yards of concrete in each column pier and 18¾

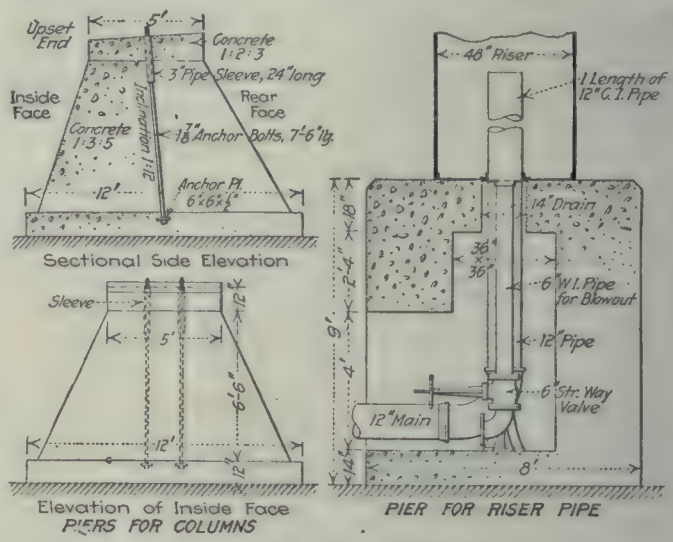


Fig. 4—Foundation piers for water tower.

yards in the central pier. The concrete is a 1 : 3 : 5 mix (made with stone), except that for the caps of the column piers it is 1 : 2 : 3. It was made in a mixer of the continuous type, and the concrete for each pier was poured in a continuous run.

The tower and tank are of openhearth steel, conforming to the specifications of the American Railway Engineering Association. The live-load on the roof is taken at 30 pounds per square foot, or 200 pounds concentrated at any point. The wind pressure is taken as 30 pounds per square foot, acting on 66 per cent. of the diameter of the tank for its full height. The steel was given one coat of paint at the shop and one field coat after erection.

The erection outfit was very simple. A light timber A-frame sufficed to raise the tower. It was just high enough to enable the tackle to be hitched above the middle of a column length, the column thus swinging free and being guided into position by guy lines. For the upper bays the A-frame was placed upon each line of struts in turn. With the tower completed, including the ring girder and the bottom course of the tank (to which the heads of the columns are attached), the next step was to place the segmental bottom. Two or three rope tackles were attached to the top of the tower, operated by a team or a hand-winch for heavy hoisting, and by hand for adjustment of the parts.

Two of the bottom plates were hoisted into place and bolted to the tank shell, and then the bottom disk or circle plate (with pipe connection) was hoisted. With the aid of tackles hitched to the circle plate and the ends of the two bottom plates, the parts were brought together so that erection bolts could be fitted. The other bottom plates were then placed without difficulty. A platform composed of a few loose planks was used in this part of the work.

The tower and tank bottom were erected in this way without any riveting.

National Organization for Industrial Research

What Other Countries are Doing and Some Suggestions as to What Canada Might Do — Future Success Depends Upon Present Action*

THE view is held in some quarters in Canada that the direction of research work, both industrial and purely scientific, should be placed under the control of the universities, and that it should be fostered and supported by grants of money from the Dominion Treasury directly to them.

It must be remembered, however, that the functions of the universities are primarily educational, and that by the British North America Act matters relating to education are not by any means national in their scope, but as to upkeep, control, and direction belong particularly to the individual provinces. The universities, as I have stated, are especially concerned with the literary, scientific, technical, and artistic training of our young men and women. It is true, generally speaking, that the best and most efficient teachers are those who carry on investigative work or direct researches. Such activities give life and vigor to the teaching and serve as a great inspiration to the students. It is also true, however, that the educational aspect of university work imposes definite limits both as to the time available for research and to the character of the researches, especially the experimental ones, which can be undertaken with reasonable prospects of a successful issue. In universities the problems attacked are, generally speaking, of fundamental or academic interest. They are such as can be solved by work carried on at intervals, or such, especially those in which students co-operate, as can through their results be used for the attainment of academic standing or the acquisition of university degrees. Problems of a secret or private nature cannot be conveniently carried out in university laboratories. In the first place, it is difficult to maintain secrecy in such institutions; and, in the second place, the solution of secret problems in university laboratories is not desirable, on account of the lack of harmony in the staff which it is likely to engender, and on account of the need therein for a high-minded and lofty scientific spirit which it would inevitably tend to suppress or at least fail to develop.

Moreover, it is doubtful if in a democracy, such as our own, public funds should be used, either directly or indirectly, for work of this character. At the same time there seems to be no reason why the Dominion Government should not subsidize research work by grants made directly to members of the staffs of the universities for researches which are of a public character and are for the public good. Such researches could, with the approval of the authorities concerned, be carried out in university laboratories, for, with the conditions at present existing, these and the apparatus in them are available for a considerable time each year. It would seem to be desirable and advisable in the interests of efficiency to use them. Research work of a secret nature or for the advantage of individual firms might possibly be tolerated in university laboratories for a time, until other facilities are provided, but in my opinion it should not be formally encouraged. Experience has shown that there are other agencies through which such work can be more efficiently and satisfactorily carried out.

Industrial and Scientific Research Commission.

In Great Britain, where they are now deeply concerned with this question, they established two years ago a commission on industrial and scientific research. It is controlled by a committee of the Privy Council, consisting of three or four members of the Government, and directed by an advisory council, consisting of a small group of men of distinction in science and of accomplishment in the industries. In Canada, through the initiative action of the Minister of Trade and Commerce, Sir George E. Foster, steps have been taken to set up a commission of a similar character.† It appears that such a body is the best agency for handling the problem with us. Among its activities it will first of all make a survey of the ground for the purpose of seeing what organizations are at present in operation and engaged in research work. It will be the duty of the commission to co-ordinate these and to extend and develop their efforts. Cognizance will have to be taken by the commission not only of the work done by the universities, but also of that done through such agencies as the national and provincial governmental departments, the Royal Society, the Royal Canadian Institute, the Society for Chemical Industry, and perhaps what is most important of all, by private firms in their works. The commission will be able to give definiteness and direction to the efforts now being put forth in this direction by the boards of trade, the Grain Growers' Association, and the Canadian Manufacturers' Association. Machinery will have to be devised to prevent overlapping. Steps will have to be taken to establish in Ottawa—and probably also in such industrial centres as Montreal, Toronto, and Winnipeg—large and fully equipped technical libraries which will contain all scientific and technical journals, trade and industrial magazines, books, and other publications, and also copies of all patents, with their specifications, wherever issued. We are sadly lacking in such facilities at the present time in Canada, and the commission should take steps to see that this defect is speedily remedied.

In Great Britain a large number of the industries

* Extract from Presidential Address of Prof. J. C. McLennan before the Royal Canadian Institute.

† The Minister, therefore, recommends the appointment of a Committee of Council to consist of the Minister of Trade and Commerce, the Minister of the Interior, the Minister of Mines, the Minister of Inland Revenue, the Minister of Labour, and the Minister of Agriculture, who shall be charged with, and responsible for, the expenditure of any moneys provided by Parliament for scientific and industrial research, and also an Honorary Advisory Committee, responsible to the Committee of Council, to be composed of nine members, representative of the scientific and industrial interests of Canada, who shall be charged with the following duties:—

(a) To consult with all responsible bodies and persons carrying on scientific and industrial research work in Canada with a view to bringing about united effort and mutual co-operation in solving the various problems of scientific and industrial research which from time to time present themselves;

(b) To co-ordinate as far as possible the work so carried on so as to avoid over-lapping of effort, and to direct the various problems requiring solution into the hands of those whose equipment and ability are best adapted thereto;

(c) To select the most practical and pressing problems indicated by industrial necessities and present them when approved by the Committee to the research bodies for earliest possible solution.

(d) To report from time to time the progress and results of the work to the Minister of Trade and Commerce as Chairman of the Committee of Council.—Extract from the Report of the Committee of the Privy Council of the Dominion of Canada Approved by His Royal Highness the Governor General on June 6th, 1916.

have shown extraordinary enterprise and resourcefulness since the war broke out, and there has appeared a greater disposition among individual manufacturers to co-operate by interchanging ideas, putting their trade secrets into the common stock, and calling in all the available scientific and mechanical resources of the country for the purpose of increasing output and improving organization. In certain trades the changes which have already taken place amount to a positive revolution. There is scarcely an industry in the country which has not come out of the ordeal of the war without being stimulated by the special difficulties which had to be surmounted. As has been stated, the history of the war in Great Britain has been a history of grave and threatening difficulties courageously faced and successfully overcome.

When the war broke out the manufacture of optical and chemical glass in France and England was practically insignificant. The steel industry was paralyzed at first by the lack of chemical glass for testing purposes, and the porcelain and pottery industries were brought to a standstill through the supply from Germany being cut off of seger cones used as guides to firing. To-day they have industries which supply all their needs. The compositions of chemical glasses have been ascertained. Methods of manufacture have been devised and have been put into operation, and through the efforts of Dr. Mellor, recently deceased, the composition of seger cones has been successfully worked out. The manufacturers of porcelain have pooled their knowledge, combinations have been effected, and research laboratories have been instituted and manned to help them through the co-operation of the Industrial Research Commission, and with the aid of the financial support of the Government.

I may perhaps be permitted to refer to another phase of the work of the British Commission on Industrial and Scientific Research. In their report, which has just been issued, they lay emphasis on what are "key" or master industries. Such, they point out, are the magneto industry, and the manufacture of lathes and milling machines, optical glass, porcelain, fine chemicals, dyestuffs, synthetic drugs, and high explosives. For such articles the market is a limited one, but the articles themselves are vital for numerous other industries. For the development of such industries the commission takes the view that state support is absolutely necessary, and steps have already been taken by that body to place a number of these industries upon a satisfactory basis. Through the action of the commission the University of Leeds has made arrangements whereby the organization known as "British Dyes" may receive substantial assistance in the matter of scientific research, and at the same time special facilities are to be given to private firms and others in the national interest. In dealing with the textile industry, support has also been given for the investigation of the nature and constitution of cellulose fibres at the School of Technology at Manchester. The commission is also supporting an investigation of the degumming of silk at the Imperial Institute of Science in London. At the Royal Technical College, Glasgow, and at the University of Manchester it is carrying on researches on the design of steam nozzles for turbines.

As a result of all these activities two tendencies have been emphasized: (1) Trade associations have been formed for common action at home and abroad, raising the average standard of production, and (2) recognition has been made of the leeway they had to make up as regards scientific research, the utilization of its results and its application to technical and industrial purposes.

The commission to which I have already referred has been a most potent factor in stimulating and promoting all these results. It has encouraged manufacturers of particular lines to combine in their efforts; it has co-operated by supplying them with information as to the technique of their industries, and it has furnished a supply of scientific men likely to help them in the solution of their problems.

Works Research Laboratories.

In addition to drawing lessons from what has been accomplished in Great Britain much may be learned also from what is going on to the south of us. In such large organizations as the General Electric Company, of Schenectady; the Westinghouse Electric and Manufacturing Company, of East Pittsburg; the Eastman Kodak Company, of Rochester; the DuPont Powder Company, the American Rolling Mills Company, the National Electric Lamp Association, the General Chemical Company, the United States Steel Corporation, the Edison Laboratories, the Pennsylvania Railroad, they have as adjuncts large and magnificently equipped research laboratories, manned by the ablest scientific men whose services can be secured, and hundreds of thousands of dollars are set apart by each of these organizations each year for industrial research.

In a number of these laboratories the activities of the researchers are not confined to the solution of problems of pressing necessity. In the laboratory of the General Electric Company, for example, the workers are encouraged to exploit fields of purely scientific interest, for it is realized that what to-day may be of merely academic interest may to-morrow have the greatest industrial importance. It is to the credit of this policy that to-day we have on the market the metallic filament electric lamp, the gas filled electric lamp, the gas arc electric lamp, gas electric rectifiers, the Coolidge X-ray tube, and the steel alloys of vanadium and other rare metals which have proven themselves so useful in the manufacture of dental and high-speed mechanical cutting tools.

In Canada our works are as yet, generally speaking, small and circumscribed in their production. We have, however, industries, such as the rubber industry, the agricultural implement industry, the cyanamide works, and the steel industry, in which a beginning has been made. All these have now research laboratories attached to their works. The Canadian Pacific Railway, too, has recently recognized the importance of this subject, and has organized in connection with its system a research laboratory under the direction of Messrs. the Arthur D. Little Company, for the purpose of exploiting the natural resources and raw materials with which it is more immediately concerned.

These few illustrations which I have cited—to which others might be added—will serve to show what steps are being taken in Great Britain and in the United States to conserve their resources and to stimulate and protect the industries of the two countries. Moreover, they point out very clearly the path which we must follow if our manufacturing interests are to be so protected and developed that they may be prepared adequately to take their part in the great industrial struggle which must inevitably follow the termination of the war.

In Canada, as in Great Britain, it will be difficult for an industrial commission of the kind I have referred to to deal with individual firms. Small manufacturers cannot afford to set up research laboratories as adjuncts to their works. It will be necessary for the manufacturers in particular industries to combine for scientific purposes, and possibly also for financial rea-

sons. For by such action it will be possible for the Government to subsidize research in particular industries. Generally speaking, it will not be found practicable, I venture to think, for such subventions to be given to individual firms for the development of research problems of an exclusive or private nature. This will, of course, lead to the creation of great trusts, as it has already done in the United States, but such a result need not necessarily prove an economic evil if we profit by the lessons they have learned, and if due precautions are taken for the protection of the interests of labor on the one hand and also on the other of those of the consumer.

We must encourage in every possible way our manufacturers to call in to their aid the assistance of the trained investigators which we are at present turning out in large numbers in our universities. We in the universities are justly proud of the product of our industry, and our only regret is that hitherto our industries have failed to avail themselves of the services of the highly trained men and women who graduate from our halls each year. To our regret and to the oft expressed regret of these graduates, the lack of openings in our own country has forced them to accept positions in the research laboratories of the United States. There they are assisting in building up great industries, rivals to our own, and in adding to the already stupendous wealth of that great country. This tide is draining us of our most valuable product, and we anxiously look forward to the time when the full appreciation of research work and of the application of scientific methods will lead our manufacturers to so orientate their industries that an efficient research spirit will prevail. May the time soon come when the mental capabilities of our people, as well as the other natural resources of our richly endowed country will be carefully conserved and developed for our own use.

Standardizing, Testing, and Research Laboratories.

In what has preceded I have dealt with the part which may very well be taken by our universities in a national scheme of industrial research. I have also emphasized what appears to me to be a most important factor in the development of our industries, namely, combination of effort and the establishment of research laboratories in connection with the works of these industries. I have also pointed out in what way it appears to me the national government may legitimately be asked to give financial aid to these two types of organization. There is, however, another phase of the question which demands consideration. In a number of the departments of government research work is being carried on continually and entirely for departmental purposes. It is felt by some that there is a danger of overlapping in this work unless some scheme of efficient co-ordination be devised. This matter is now, I believe, under consideration by those immediately concerned with it, and it is possible that, as a result, it may be found necessary to establish in different localities in Canada laboratories in which much of this work can be done under one or more directing bodies, consisting of the permanent officials interested in the matters taken up, and of others whose scientific attainments and qualifications may be such as to make them desirable members of such body or bodies. Departmental activities which might be cited as being preeminently suitable for being carried on by such organizations, are the standardization of weights and measures, the calibration and testing of meters and measuring instruments of all kinds, the testing of foodstuffs, the analysis of drugs and chemicals, the development of ceramics, the investigation of marine lighting and signalling, the treatment of ores, and the investigation of the properties and treatment of natural products, such as fish, oils, natural gases, peats, and minerals of all kinds.

The working out of a scheme which will embrace all these different types of activity will be a task which, I think you will agree, will tax the powers and capabilities of the Commission on Industrial Research to which I have alluded. It can, however, be done and effected very speedily if there be a general recognition of the difficulties involved, and if a general and hearty desire be evinced by those whose co-operation is sought to assist in working it out.

It may be said that much of the research work to which I have referred can be accomplished in the laboratories of our universities. That some of it can I will readily admit, but I venture to think that if a serious attempt be made to meet the needs of our country in an adequate manner, it will be found that university organizations possess limitations in the way of space requirements, continuity of effort, and administrative machinery which effectually preclude them from assuming the direction of anything more than a minor part of the industrial research work of the country.

What is wanted is, in my opinion, first of all a consolidation and correlation of the research work now being carried out at Ottawa in different departments and under different ministers.

In my opinion, the magnificent work which is now being done under the Geological Survey and in the Department of Mines at Ottawa could very well be extended. Increased laboratory accommodation should be provided and additions made to the staff of highly trained technical experts. Sections should also be attached in which problems of a physical and chemical nature can be treated. Problems of this type are now being dealt with by a number of the governmental departments at Ottawa, but, in my opinion, all these activities should be co-ordinated with the work in the Geological Survey referred to above, and the whole placed under the direction of one board, embracing the highest technical and scientific opinion available in the country. If such consolidation were accomplished, it could be done on a basis and in a manner to provide for the most powerful and the most efficient scientific direction.

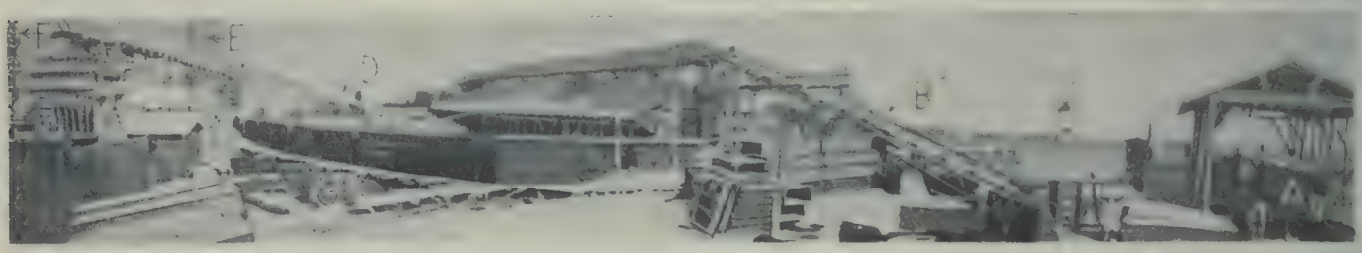
In the second place, I think the facilities afforded by the universities should be supplemented by the establishment of a few physical and chemical research bureaus or laboratories in the centre of those localities in Canada where the industrial activity is the greatest. For example, under the conditions at present existing, it would seem that one of such bureaus could with advantage be established in the Province of Quebec, either at Montreal or Quebec—preferably at Montreal. Another should be established at Toronto, probably a third at Winnipeg, and later on a fourth in British Columbia, and maybe a fifth at some centre in the Eastern Provinces. These bureaus, implementing the facilities offered by the universities, could be made somewhat elastic in their organization, and they could become most efficient institutions for assisting the departments of provincial governments in their scientific work, and for co-operating with manufacturers by providing them with scientific information and advice and by investigating for them numerous scientific problems which are pressing for solution.

Messrs. F. H. Hopkins & Co., whose head office is in Montreal, have opened an office in Toronto, at Room No. 108, Mail Building.

Twelve Hundred Yards of Concrete Placed in 24 Hours Using Efficient Conveyor System

A record of 1,200 cubic yards of concrete deposited in twenty consecutive hours was made August 23 on the new 6,000,000-bushel grain elevator which the Chicago and North Western Railway Company is building for the Armour Grain Company at One Hundred and Twenty-fourth Street and the Calumet River, Chicago. The following description of the work appears in the Engineering Record:

There are in the storage portion being built at present 104 circular bins, 105 ft. high and 22½ ft. in diameter. They are being constructed by the continuous rising-form method. The entire bank of 104 tanks, aggregating 168 yards per vertical foot, was under construction when the record was made. Sand and gravel were supplied to the mixers by mechanical equipment that eliminated all hand work, and to this fact the contractor attributes the success of the concrete plant. Belt conveyors carry the aggregate from the bins, into which bottom-dump cars discharge to the charging bins over the mixer, but there is an intervening "storage reservoir" of 2,800-yard capacity between the cars and the mixer, so that any temporary irregularity in the supply of material is equalized.



Three Mixer Plants with which 1200-yard record was made supplied continuously by extensive conveyor system.

Railway cars at right unloaded into hoppers feeding belt under track. This belt discharges on inclined conveyor B, which loads large storage bins C. A belt under these bins feeds the inclined cross-conveyor D, which delivers material at the centre concrete plant E, for use there or to be conveyed to the west plant F, or the east plant, out of sight behind the right corner of the tanks. Cement is handled on the runways G.

Concrete Supply Plants.

There are three complete concrete plants erected in a line at the south end of the bank of tanks. Parallel with this line and 150 ft. farther to the south is the "reservoir," a 200-ft. length of material bins supplied at the west end by a track running north and south. A cross-belt conveyor connects the storage bins with a conveyor running over the top of each individual mixer storage bin. A track with a continuous platform along the line of the mixers enables the supply of cement to be maintained with little use for the small 600-pound sheds placed for emergency near each plant.

Handle Bottom-dump Cars Quickly.

Beginning at the aggregate end, bottom-dump cars, three at a time, are hauled up a slight incline by a one-drum 22 h.p. electric hoist over four hoppers. From one of them the material drops directly on to a 315-ft. 24-in. conveyor delivering to the storage bin. This runs at 300 ft. per minute up an incline on a 20-degree slope, and has a capacity of 200 yards per hour. The three other hoppers under the cars feed a belt running parallel with the track and discharging on the main supply conveyor. Two cars may be dumped at one time, and as many as five cars have been unloaded per hour. The heat was so intense this summer that a shed had to be built over the unloading outfit.

The belt over the storage bin is 36 ft. above ground level and a traveling tripper works back and forth distributing the sand and gravel evenly over the length of the respective bins. The gravel bin holds 1,800 yards and the sand bin 1,000 yards. A second belt, 4 ft. above ground, draws from the storage bins, which were built entirely above ground on account of the boggy nature of the site, and discharges on the cross-conveyor. The latter elevates the material about 40 ft. and discharges it either directly into the central plant hopper or onto belts running to the plants at each end of the line.

Each concrete unit consists of a 140-foot two-compartment tower, a 1-yard Marsh-Capron mixer, and a system of chutes with a swivel leg and balanced cantilever discharge spout reaching a maximum of 100 feet from the tower. Aggregate bins of 40 and 80-yard capacity for sand and gravel respectively deliver into the mixer through measuring chutes, and in less than a minute a bucket of concrete is mixed and shot up the tower at the rate of 300 feet per minute by a 90 h.p. special Thomas elevator hoist.

Water for the mixers was supplied from the river by means of a 4-inch triplex pump driven electrically by a starterless Wagner motor controlled by an Anderson automatic cutoff switch. The service was such as to start the pump operating every few minutes to keep up the required 80-pound pressure.

Distribution of Labor.

The distribution of men engaged in the concreting process is as follows: Eight men unloading cars, three men attending to the conveyor belts, six men handling cement; and for each plant in use two men manipulating levers for aggregate and water; one man on the hoist and one man at the top of the tower. The number of men handling chutes, spreading concrete, and manning the jacks to raise the forms varied too much to give accurately.

It is to be noted that the 1,200-yard record was made with only one mixer outfit, which operated continuously two ten-hour shifts, or a total of twenty hours.

During the extreme dry and hot weather the 315-foot main supply cotton belt stretched to an extent which could not be compensated for by the take-up and which proved a source of annoyance. To obviate this difficulty wetting of the under side of the belt with a hose was resorted to. This proved efficacious, and thereafter the belt was thoroughly wetted every three days for a period of two hours. The conveyor system was furnished by the Stephens-Adamson Manufacturing Company.

Practical Hints for the Contractor

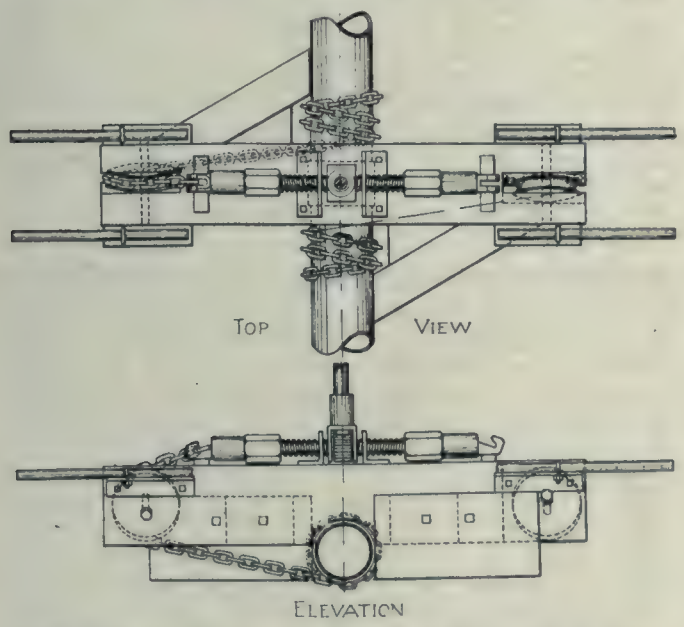
that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Powerful Pipe Wrench Dismantles Large-Diameter Pipe Line

By James Ryan and E. C. Entler

The Engineering Record contains the following descriptive method for dismantling a large-diameter pipe line:

In removing a line of about 4,000 lineal feet of 6 and 8-inch pipe with screwed joints which had been in



Wrench broke out, with ease, joints of 8 in. pipe line in place five years.

place for about five years the pipe wrench shown in the illustration was used with great success to break the joints. It was rigged from a steamboat ratchet and a 12 x 12-inch timber 6 feet long. With this rig it was possible for one man to start the joints on 8-inch pipe.

In operation the wrench was placed astride the pipe and centred over the coupling. Then the chains were given several turns around the pipe, carried over the sheaves at the ends of the wrench and hooked into the special hooks on ends of the ratchet, the screw at the start having a hold of a few turns in each sleeve. Then by means of the handle and ratchet the chain was quickly tightened up and the joint broken, in most cases with a jump. The sleeves on the outer ends of the ratchets were kept from turning over by the short pieces of steel shown on the bottom of the hooks. The short diagonal struts on each side of the 12-inch timber rested against the pipe and took the pull of the chains. The handle used in the ratchet was about 3 feet long.

Two short pipe handles at each end provided means for carrying the wrench from place to place. For clearness the chain is shown on one-half of the sketch only, the other half being the same.

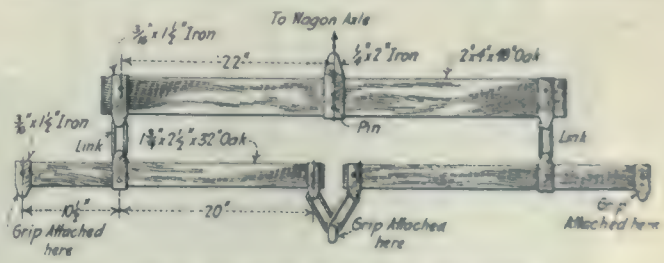
This rig could also be used for tightening joints in pipe-laying by reversing the chains and the diagonal braces.

Stretching Three Wires at One Time

An interesting method of stretching the three wires of a power line at one time is illustrated herewith. When constructing three-phase transmission lines a great waste of time is often caused in stretching conductors by the awkwardness of the block and tackle method. This scheme enables a small force of men to stretch all three conductors of a three-phase line in one operation. In other words, the three conductors are strung, stretched, and tied in with one trip over the ground and by climbing up each pole once. To facilitate stretching all three wires at once a special whiffle-tree constructed as shown in the accompanying illustration is used. This device and a crew consisting of a foreman, four climbers, a team with driver, and a helper on the wagon to watch the reels and fasten the wire grips, can handle line construction rapidly without difficulty.

The main beam of the special whiffle-tree is made of oak, 2 in. by 4 in. by 48 in. long. The single-trees are also of oak, 1¾ in. by 2½ in. by 32 in. long. A clevis, ¼ in. by 2 in. iron, fits the main beam at its centre and is held by a pin. Two other clevises are of 3/16 in. by 1½ in. iron, one placed at each end of the main beam on 22 in. centres. Six other clevises are made of the same stock and fit the ends of the single-trees. The spacing is shown in the diagram. The links used with the clevises are made of ⅜ in. round iron. This special device is attached to the axle of the wagon by a chain so that it drags about two feet behind the rear wheels. Three reels are mounted upon the wagon platform and carry the wire.

When stringing the conductors for a particular line, each conductor is dead-ended at the starting point



Special whiffle-tree for stretching three wires.

and the team driven six spans for the first pull. Each climber takes his assigned place, one at a pole, the foreman making the fifth, and each carries the wires up the pole, the helper meanwhile at the wagon making fast the wire grips on the conductors, thus attaching the special whiffle-tree to them. The driver then starts the team and draws the wires taut. The brake is then applied on the wheels of the wagon to aid the team in holding the strain. After the four climbers have tied

in the line the grips on the special whiffle-tree are released and the team driven up four spans, thus unreeling wire for another pull, and the cycle of operation is repeated. Four spans have been found about the maximum pull on an upgrade that can be made with one team of horses; however, on a downgrade as high as seven spans have been stretched without any difficulty at one pull.

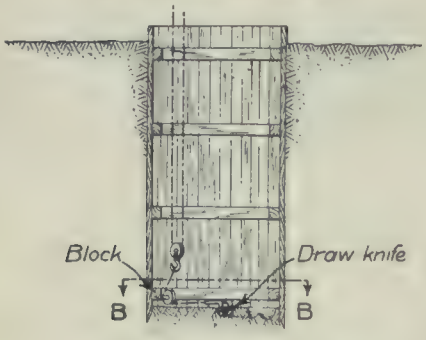
This method of construction makes possible a very taut line, does not produce twisting upon any pole, makes all wires hang alike, and is considerably faster than the block-and-tackle method. An average of three miles of line has been strung, stretched, and tied-in in one day.

Draw-Knife Pulled by Hoist

By D. H. Fleming*

The accompanying sketch shows how a hoisting engine was rigged up to pull a drawknife for cutting out strips of puttylike blue clay in sinking a 12-foot square shaft for constructing a brick-lined sewer tunnel. A steam hoist and buckets were the only plant on the job, and excavating the tough clay by the pick-and-shovel method proved a very slow process.

SECTIONAL PLAN BB



SECTIONAL ELEVATION AA

Draw-knife pulled by hoist.

To get around the difficulty the contractor fastened a single block at the bottom of the shaft, in one corner. Through this was run a line, to the upper end of which was hooked the hoisting fall and the lower end of which was attached to an ordinary excavating drawknife. In order to give the knife a start, an advance trench about 6 inches wide and a foot deep was cut on the two sides, opposite the corner in which the block was located. Long slices extending across the shaft could then be cut out by the drawknife. These were cut up into 18-inch lengths by one man with a spade, while another threw the pieces into the bucket and two others guided the drawknife. The device more than doubled the amount of excavation taken out in a day, while the daily cost remained the same.—Engineering Record.

* Assistant City Engineer, St. Catharines, Ont., in Engineering Record.

"Safety First" Nets

In certain localities, safety nets are now being used for the protection of men engaged in the erection of steel and iron structures, replacing planking, where this would be impracticable. The safety nets are similar in character to those employed for the protection of circus performers. They are claimed to be inexpensive, easily transported and removed, and readily adjusted and applied. They are suspended between points where the men are working. The rope netting has been found better than steel wire netting.

Used Rubber Hose and Long-handled Rollers

In finishing the surface of a concrete road in Myers Park, Charlotte, N.C., W. C. Campbell, the contractor, used long-handled rollers and rubber hose. The photograph shows how the work was done. The concrete is formed to the shape of the finished roadway by means of wooden rollers 12 in. in diameter and 4 to 8 ft. in length. These are provided with long handles and are operated from either side of the road. Transverse joints are made at intervals of 30 ft. The joints are made with two thicknesses of two-ply tar roofing paper, so placed that they come to within ¼ in. of the surface, forming blind or concealed joints. The surface finishing is done with an ordinary garden hose, made of rubber. This is dragged over the surface by two laborers from the concrete gang. The work is done at such times as the mixer is being moved ahead. No other finishing is given the surface.

Latest method of finishing concrete road with long-handled rollers and garden hose said to produce good surface at low cost.

Big Grain Elevator for St. John, N.B.

Tenders have been called for the construction of the superstructure of a grain elevator at St. John, N.B., for the Canadian Government Railways. The contract for the foundations, consisting of concrete piles on rock has been let to Engineers and Contractors Limited, St. John. The elevator is to be built of reinforced concrete, will be of the up-house type, and will consist of a working house with a belt gallery. It will be on a site 106 x 93, and will be utilized for receiving grain from railway cars and discharging it into ocean vessels. The capacity is 550,000 bushels. Reinforced concrete will be used up to the top of the bins, and above that will be structural steel and corrugated iron covering. All the floors will be of concrete. Two railways will run through the first storey. The plans provide for three elevator legs, two for receiving the grain from the cars and the other for shipping, although all can be utilized for shipping. There will be a track hopper beneath the loading place for each car, and the hoppers are of a capacity to each hold a car load. The grain is to be elevated from the track hoppers to the top storey of the cupola, and from this point will be discharged by gravity to 2,000 bushel garners. Beneath every garner a 2,000 bushel scale hopper is placed, and from the scale hoppers the grain is distributed through the spouts to various bins. The elevator will be electrically driven by individual motors, while electric signal and telephones will be installed. The plans have been designed by the John S. Metcalf Company, Limited, Montreal, who will also supervise the work under the direction of Mr. C. B. Brown, chief engineer of the Canadian Government Railways.

Fireproof Doors

The Pedlar People, Limited, of Oshawa, Ont., are distributing a very attractive booklet, entitled, "Pedlar's Saino All-metal Fire Door," containing complete information regarding this fireproofing product. The Saino all-metal fire door is stated to be radically different from any fire door previously placed on the market. It is made of two walls of cross-laid 22-gauge galvanized corrugated steel, with air chambers, and interlined with heavy asbestos. Patent telescope channels and joints provide for expansion and contraction along straight lines without distorting the door. The heavy cross-laid corrugations give extreme strength, while the elimination of the heavy wood core gives light weight —five pounds per square foot. The large air spaces in the corrugations, supplementing the heavy asbestos, give maximum resistance to heat, as the fire-retarding qualities of the door are not materially affected by the sudden cooling and impact due to the application of a fire stream while under extreme heat. These doors are tested to 500 degrees above the conflagration point. By all these precautions the radiation of heat through the door and the amount of flame, heat, or smoke passing round the edges of the door are reduced to a minimum. The illustration herewith shows the asbestos lining between the two walls of cross-laid 22-gauge corrugated iron, thus preventing the transmission of heat in case of fire. The strong, reinforced frame holds the covering firmly in place, while the expansion joints permit it to expand and contract along straight lines without warping. This is a back view of the Saino fire door.

Pumping Outfit for Charlottetown

The city of Charlottetown, P.E.I., have awarded a contract to the Canadian Fairbanks Morse Company, Montreal, for the supply of a pumping outfit, consisting of a Goulds Fig. 3030 No. 6-S horizontal single-stage double-suction brass-fitted centrifugal pump, with base plate, fitted with outboard bearings and pulley. The pump will be belt-driven from a Fairbanks-Morse 15 h.p. type "Y" semi-Diesel oil engine. The machinery will have a capacity of 850 United States gallons per minute against a normal total head of 30 feet when operating at 975 r.p.m. The engineers are Messrs. R. S. & W. S. Lea, New Birks Building, Montreal.

The Canadian Siegwart Beam Company, Limited, Montreal, have closed a contract for the supply of 104,000 square feet of Siegwart beams, to be used in a shed being erected for the Quebec Harbor Commissioners.

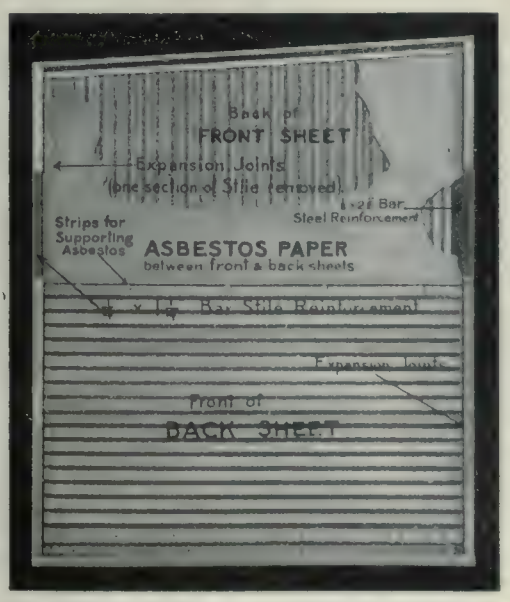


Fig. 1—Sectional view of Saino fire door, rear side.

Fig. 2—Front side of fireproof door.

Construction of High Tension Transmission Lines and Steel Towers

By Mr. Lesslie R. Thomson*

The truest economy in transmission line design may only be attained by a close co-operation between the electrical and structural engineers after a careful weighing of all the various conditions that affect the whole project. The following few notes are prepared from the point of view of the structural engineer who may be called into consultation when a transmission line is under consideration:

General Characteristics.

When electrical power is to be developed and then carried over any considerable distance, the necessary transmission line becomes one of the most important items in the estimated cost of the whole installation. It will be admitted that the aim should be not to so design the line that the original investment is a minimum, but rather to so lay out the whole scheme that, consistent with satisfactory operation, the annual outlay is reduced to the smallest possible dimensions. Before going further it would be well to note at this point that the term "satisfactory operation" is a very difficult one to either define or equate to a definite financial basis, but an attempt will be made, however, to reduce it to tangible terms.

Annual Cost.

The annual cost of a line may be assumed to divide itself roughly under the following heads:

I. Interest on the original capital investment.

II. Depreciation.

III. Operating costs, e.g., engineering services, repairs, patrolling and (a) any premiums on accident or interruption, liability insurance, or (b) the annual equivalent of any monetary damages due to interruptions to service (unless covered by policies under III.-a).

I., II., and III. are not isolated or independent channels of expenditure, but are related one to the other, and will, consequently, overlap to a certain extent. It is desirable to touch briefly on this interdependence. In the past it was often considered that if the capital investment was reduced to a minimum the line would then be the most economical one possible. This is now felt to be only partly true, for a cheaply-constructed line, with frequent interruptions and accidents, with perhaps heavy damages, may prove in the long run to be far more costly than a well-designed line involving a larger capital outlay. The problem thus resolves itself into preparing a design on which the sum of I., II., and III. is a minimum.

I. Capital Charges.

It will be readily seen that items I. and II. will contribute a fairly important part of the total annual cost, and, consequently, any attempt to reduce the capital investment will result in the reduction of both the interest and depreciation charges. The following list comprises the various heads under which the capital expenditure is distributed: (a) Wires and splices; (b) towers or poles; (c) insulators; (d) guy wires; (e) right of way complete, or (f) land for towers, with right of passage for overhead wires; (g) foundations; (h) erection, including the delivery of the towers; (j) engineering services.

The cost of all the foregoing will vary, of course, with every change in the layout of the line. The minimum clearance of wires from the earth, all the electrical characteristics, such as voltage, number of circuits, number of phases, power per circuit, sizes and types of insulators, etc., and the average span length, will all affect the total capital cost. But for purposes of discussion, from the point of view of this paper, it may be assumed that all electrical features have been fixed, together with the minimum clearance of wires from ground. This leaves span length as a remaining variable whose changes will affect the capital cost.

The effect of span length on capital cost is a little difficult to predict with any certainty, but various characteristics undoubtedly influence it, and these characteristics will be examined. Reverting now to the list of headings under which capital expenditure may be distributed, it will be noticed that the cost of certain of them will be practically unaffected by any change in span length. These items are (a), (d), and (j). The cost of wires and splices may be assumed to be independent of span length, for most transmission cables are strong enough in any event to carry their loads over comparatively long spans, while the increase in cable length—due to larger sags—may be neglected. Similarly the cost of guy wires (d) and of engineering services may be regarded as being independent of span length.

The items now remaining are those whose costs vary with the changes in the span length. If short spans are to be used there will be a large number of light towers, or perhaps poles, with consequently heavy costs for insulators and possibly for erection. On the other hand, the right of way will be less expensive than were longer spans desired. This will be easily appreciated when one considers the fact that long spans necessitate increased distances centre to centre of conductors at cross-arms, and also large sags in the cables, which, in heavy winds, must have wide arcs of swing. These facts naturally require for the line wider limits, and, consequently, a more expensive right of way, in order that the cables shall at all times and under all circumstances remain within the limits of the property or passage right acquired. As the spans increase in length the towers become, of course, heavier, but there are naturally fewer of them to the mile, and it must be borne in mind that the cost of insulators varies directly with the number of towers. Pole lines usually have spans of 150 feet to 300 feet long, while tower lines have spans of from 300 feet to 2,500 feet, depending on the judgment of the engineer. In flat country a succession of equal spans with as few horizontal angles as possible will give the most economical arrangement. In mountainous country the high points along the line should be selected for the tower sites, and very little effort should be made to keep all spans of equal length. For sake of repairs, shipping, storage of spare parts, etc., all towers should be made alike unless some exceptional circumstances should demand a few special towers. By selecting high points for the towers in rough country a considerable saving may often be effected, owing to the fact that the conductors will, in general, be above the trees, and consequently the necessity for a large amount of expensive clearing on the right of way is obviated. Also tower sites in mountainous country should not be placed in the path of possible snow or land-slides, while towers placed near rivers that are liable to overflow their banks should be protected by cribs or piling. The cost of foundations will naturally increase as the number of towers increases, and will, in general, be cheapest per mile when long spans are selected. The cost of erection will, within certain limits, vary directly as the number of towers. The question of lightning also enters into the discussion to a small extent. It has been found to be particularly true that lightning most frequently discharges through one of the pin insulators to the tower rather than travels along the line to a

* Before Canadian Society of Civil Engineers, Montreal, Nov. 16th, 1916

lightning arrester provided for the purpose. Consequently the fewer towers and insulators, with, however, the same number of lightning arresters per mile, the less likelihood of damage by lightning.

Structural steel poles are the more economical for short spans, and, without further comment, will be assumed to be used. The advantages of short spans with poles are as follows: Short cross-arms and small bases permit narrow rights of way; frequent supports for conductors, by reducing sags and hence swings, enable lines to have a narrow right of way; steel in poles is likely to be economically used; and riveting on poles is done in the shop, which is superior to the field-bolting necessary for towers. The disadvantages are higher costs for steel supports and insulators per mile. It will have been recognized by this time that great emphasis has been laid upon the cost of right of way and the saving that may be effected by reducing its width. The importance of this can hardly be overestimated, especially in regions where land is expensive. It will generally be found that in modern transmission lines entering cities or towns the saving in cost of right of way more than compensates for any increased cost of insulators or poles.

II. Depreciation.

The depreciation in the towers depends on the type of protection afforded, severity of climate, presence of chemicals in either the air or ground, and on the amount of original "stability" provided. By the term "stability" is meant that excess thickness demanded by the structural engineer for sake of rigidity. For example, it may be often found that when a 2½ x 2½ x ⅛ angle might perhaps figure, the engineer will insist on 2½ x 2½ x ¼, because of his distrust of thin legs, or because of specification requirements on minimum thickness.

The protection usually given to towers and foundations is either galvanizing or paint. If it be desired to paint over the galvanizing, though this is usually regarded as quite unnecessary, a special paint must be secured.

III. Operating Costs.

Operating costs are capable of being fairly closely estimated before the line is built, but the discussion of them lies outside the scope of this paper. It will be remembered, however, that they must be estimated when "satisfactory operation" is being furnished. As mentioned above, this is difficult to define, but some idea may, however, be formed of its financial equivalent. Most engineers agree that a large amount of power is entitled to more insurance than a small amount, whether this insurance be paid directly in the form of premiums or whether it be paid in the form of increased interest charges on a larger capital investment. Again, certain services, from the very nature of the case, must be continuous. For example, a city engineer whose low tension bus bars supply power for lighting, street railway, and general office service, would probably consider one shut-down a year of even ten minutes' duration as very unsatisfactory, for there would be investigations without number enquiring why citizens were stalled in the streets, caught in elevators between floors, etc., etc. On the other hand, power delivered to electric pumping stations in a small locality would be satisfactory if they had power for 75 per cent. of the day.

Having reduced the question of "satisfactory operation" for different types of service to a definite basis, the engineer should use his own judgment as to the amount of insurance the service needs, and thus the financial equivalents for various types of service may be approximated. It is interesting to note in this connection that many engineers feel that it is impossible to provide absolutely continuous service over one circuit. If two circuits are provided, they may be either on the same tower or on separate towers, with the same or independent rights of way. It is on questions of these kinds that the judgment of the engineer must be exercised to obtain the most economical solution.

Loads.

The loads on a transmission line tower are of three classes, each system at right angles to the other two. They may be described as the (a) dead, (b) transverse, (c) longitudinal and will be discussed in order:

(a) The total dead load is obtained by taking the sum of (1) tower itself; (2) weight of all wires supported by the structure; (3) the weight of the snow or ice coating. It is on this point that climate enters into the question. In the south ½ inch of ice coating is sufficient, but in northern countries like Canada more allowance must be made. The Montreal Light, Heat, and Power Company assumes ¾ in. on each side, making the diameter of the cable 1½ in., plus its own thickness. (From information supplied to the writer by Mr. R. M. Wilson, chief electrical engineer of the M. L., H., and P. Co.)

(b) The transverse loads arise from the action of the wind on the towers and cables. It is usual to neglect the wind pressures on cross-arms and insulators. The most frequently assumed wind pressures in England and the United States are 56 pounds and 30 pounds per square feet of exposed normal surface. A cylindrical surface is usually considered to present 0.6 of its projected area as an effective normal surface. In America it is readily recognized that wind pressures up to 50 pounds per square foot are quite possible, but only over small areas. For any considerable surface 30 pounds is felt to be a liberal estimate. It is a matter of observation that wind pressures decrease as one approaches the ground. For the foregoing reasons it seems adequate to take the following pressures, and they are recommended: (1) On structure itself (on two series of faces), 30 pounds per square foot; (2) on bare wires, 15 pounds per square foot; (3) on projected area of ice-covered wires up to ½ in. of ice, 10 pounds per square foot; (4) on projected area of ice-covered wires with more than ½ in. ice, 8 pounds per square foot.

The only question about which any doubt may be raised in the foregoing is the allowance of heavy wind on coated cables. Many engineers feel that these never occur simultaneously, and some are dubious as to whether sleet ever forms in a conductor carrying an appreciable amount of electrical power. But the majority will admit that ice and wind do occur together, and hence the necessity of providing for it.

(c) The longitudinal loads are obtained by assuming one or more conductors to break, and thus place on the cross-arms an unbalanced load—tending to produce torsional effects in the towers. Certain specifications insist that provision shall be made for all wires on one side of the longitudinal centre line of tower, breaking together with the ground wire, while others only require one conductor and ground wire per circuit.

Angles.

When turning longitudinal angles the usual practice is to put in standard line towers unless this angle exceeds 10 degrees. In the latter event either a standard tower with wire guys or a special tower designed to carry the actual loads is placed in position, bisecting the angle of the line. The use of a special tower is the better practice, as the transverse guys introduce more or less indeterminate stresses.

Tests.

During the last decade or so purchasers have been insisting on actual mechanical tests of a certain number of towers before acceptance for delivery of any of them. The test loads usually specified for each type of loading are double the actual values (calculated). It is customary for the specifications in use to read "the tower shall not fail," and this is usually interpreted to mean that no member or part shall fail by buckling or parting. In a well-known international transmission line the tests were of two sorts (a) and (b). For tests (a) the towers were set on rigid foundations, in the manufacturer's plant, and all calculated loads were doubled

and applied. In tests (b) the towers were set up on special field foundations and 90 per cent. of loads used in tests (a) were applied.

This specification is indicative of a growing conviction among engineers that the effect on the towers themselves of non-rigid foundations may no longer be neglected. It is evident that if the foundations of a four-legged tower are somewhat elastic with irregular settlement there will be an entirely new stress distribution within the structure. This point will be touched upon more fully under the head of "Foundations."

It is well to realize that these test factors bear a close relation to the unit stresses specified; and they will be discussed later under unit stresses.

Unit Stresses.

Working stresses for the towers of a transmission line are to be used with loads that may actually occur at not infrequent intervals, there being no impact whatever. On the other hand, their maximum values are capable of being actually determined. Hence it is a little difficult to relate them intelligently to bridge stresses. Certain engineers feel that conservative unit stresses for towers are somewhat in the nature of an insurance or guarantee, and that for lines not so important as trunk lines higher stresses may justifiably be used. In this connection R. Fleming divides proposed towers into three classes—A, B, and C—and allots unit stresses for each class, depending on their importance, thus:

Class A.—Towers for a line whose purchaser insists upon uninterrupted service, with heavy penalty clauses. Cases where failure of tower would mean probable loss of life, as in thickly populated regions.

Class B.—Towers for a line where certain interruptions are not inadmissible. Towers for a line through sparsely settled country.

Class C.—Towers that must be put up as cheaply as possible, independent of all other considerations.

He then gives the following unit stresses for open hearth structural steel: Class A, 22,500 pounds per square inch; class B, 27,000 pounds per square inch; class C, no definite figure given, but the inference is that certain engineers assume that wind and ice-covered cables are not considered as occurring simultaneously, and the resulting loads are figured at 30,000 pounds per square inch. He condemns this high figure as being too near the elastic limit, and does not commit himself as to the assumption. Before this question of the unit stresses to be used can be finally settled their relation to the test safety factor must be discussed briefly.

It was noted in the preceding paragraph that many purchasers insist on test loads of double the actual calculated load. If, for example, the tower under test belonged to class B of Mr. Fleming's list, and the material were closely designed, the resulting stress in certain of the members would be 54,000 pounds per square inch. This is much beyond the elastic limit, and the tower would probably fail. If, however, instead of an arbitrary test factor of 2, the purchaser would insist upon a test safety factor having for its magnitude the ratio between extreme elastic limit and unit stress desired (which should be conservative), and would at the same time stipulate that the maximum combination of loads must be used, the resulting towers would be in no danger of being weak or badly detailed, and rigid tests to elastic limit would be not only possible, but would be welcomed by the manufacturer.

Conductors and Wires.

(a) Conductors.—These are, in general, of three different kinds—(1) copper, (2) aluminum, (3) steel reinforced aluminum. The latter two are the ones frequently used in transmission lines to-day owing to the high price of copper. A cable often used by the Montreal Light, Heat, and Power Company for high tension service consists of a steel stranded core of 78,500 c.m. and a stranded aluminum sheath of 336,420 c.m., with a total diameter of about 0.74. As mentioned above, this paper does not intend to do more than touch upon these purely electrical features that may need, however, to be mentioned in passing.

(b) Ground Wires.—These wires may be of either stranded or solid steel, and are about ½ in. in diameter. Those engineers who place reliance in the capacity of these ground cables to save the lines from lightning usually assume that they protect all conductors underneath and within 45 degree lines.

(c) Stresses and Sags.—The stresses and sags in any of these conductors may be found from the well-known equations which are presented in very clear form in an article entitled "Mechanical Stresses in Transmission Lines," by A. Guell, Bulletin No. 54, the University of Illinois, Eng. Exp. Station.

(d) Swings.—As the swing of wires between supports often affects the width of right of way, the following vertical swing angles will be of service in allowing for this characteristic: Copper conductors, 45 degrees; steel aluminum, 50 degrees; aluminum, 55 degrees.

(e) Insulators.—Insulators are of two main types—the pin and the suspended. The former are used almost universally up to voltages of 60 or 70 kilowatts, while for higher voltages the suspended insulators are preferred, the number of units being dependent on the amount of the voltages. Pin insulators for h.t. service are always of the petticoat type, and are manufactured in a great variety of designs. The modern practice is to use wrought iron or steel pins, and care should be taken that the insulators are strong against electrostatic puncture to the pin. The ratio of the resistances to puncture and to flash over should be about 1.6.

If possible, pin insulators should be used on account of their many superior characteristics, chief among which should be mentioned their rigidity. The advantage of a rigid support for the conductor is manifest should there be any tendency of the wire to "whip" under the following conditions: Suppose, for example, there is a heavy coating of sleet on a conductor with a warm sun and wind. The sleet will, in general, be melted off in large blocks rather than gradually. These long blocks of heavy ice, suddenly released, impart to the wire a whipping effect in a vertical plane, which is transmitted along the wire by a wave-like motion. If the point of support is rigid the whipping is arrested, but if not it may jump high enough to touch part of the tower or even meet another conductor. For this reason conductors on suspended insulators are seldom, if ever, in modern design, placed vertically over one another. Often each conductor is suspended by two strings of insulators, each set at a good angle to the other in order to secure greater rigidity.

Suspended insulators are of two or three main types, each unit being a duplicate of every other one. The bell or petticoat units are familiar to all.

With whatever type of insulator a h.t. line be equipped, it is to be borne in mind that the first two or three years will be in the nature of test years, for electric storms will in that time be pretty sure to have discovered the weak insulators, and, irrespective of any lightning protection, a marked improvement in the annual insulator cost should be apparent by the end of the third year.

(f) Ties.—The design of the tie is always dependent on its required function. Certain ties are designed to be rigid, and to hold the wire not only from vertical displacement but from longitudinal movement as well. Such ties would be placed on any dead end or anchor tower. Sometimes it is desired that in the event of a cable breaking the entire longitudinal pull shall not be given to only one tower, but rather distributed over two or more. In this latter event the tie is designed to allow a certain amount of slip. In certain instances it or the pin is designed to break absolutely should the load become more than nominal (e.g., ties to a so-called "flexible" tower). Whatever type of tie to pin insulators be adopted, there are two points that should not be overlooked—

first, protection must be given the conductor against arcing from it to the grounded pin; second, protection must be given the cable against confined arc occasioned by a puncture of the insulator. The first is usually afforded by a large amount of serving in the cable by the tie wire and the second is accomplished by extra parcelling around the cable with either soft copper or aluminum plate.

Poles.

The two following sections touch respectively on the design of poles and towers. The distinction between these may be clearly drawn in a few words: A pole is a steel or iron structure whose ratio of base width at ground level to height is small. This ratio is usually in the neighborhood of 1.10 or smaller. A secondary distinction may be drawn from the base support, which is nearly always monolithic, and consequently acts as a unit in supporting the load.

By a tower is meant a light fabricated steel structure, in which the distance at ground level between main upright supports in any one direction is large compared with the height of the structure. A usual value for this ratio is ¼.

The design of steel transmission poles has crystallized into a three or four-latticed angle type, with a triangular or square base respectively, back to back angles about 1/12 of the height to the first of the conductors. These are set on pin insulators vertically over one another at about 6 feet centres for 66 kilovolts, and a ground wire is located at the same distance above the uppermost conductor. Frequently the sides of the pole are slightly tapered toward the top, where the distance back to back of angles is about 1/24 the height from ground to first conductor. Horizontal bracing is usually placed in these poles at about 1/3 points to aid in resisting torsional loading. The pole is set into a concrete foundation for about 6 or 7 feet, while the enclosed space between the main leg angles above the foundation is frequently filled with concrete for a height of about 5 or 6 feet. By selecting comparatively short spans the sag may be reduced to very small quantities and hence the height from ground to first conductor may be kept down.

Towers.

(a) General Hints on Design.—Designs for towers have not absolutely crystallized as yet, but for rigid towers two main types are emerging from the mass of all sorts of odd designs that have from time to time appeared. For the want of better terms they may be described as the braced A frame and the windmill type. The latter are the more frequent, especially for the longer spans which necessitate higher towers.

In designing a tower the spans should first be approximately determined and the classification of the tower selected on the type of service required. The various loads are then figured—dead, ice, wind, and breaking. The grouping of the wires is usually determined from electrical considerations, and, with a knowledge of maximum sag for a span, the heights of each wire may be determined from ground elevation. The outline of the tower and cross-arms may be then sketched in as a trial. Every effort should be made to have the stress lines as direct as possible. It will be noted that any load, in any direction whatever, imparted to the tower at the insulator supports is conveyed to the ground in tension and compression by the four main legs, and in tension by some of the main diagonals. The great directness of the straight line stress route is very desirable. It obviates the customary crossing back and forward by alternate diagonals and struts, which inevitably tends toward loose joints in a light, bolted structure like a transmission tower. Another result is to reduce the detail weight in connections, etc., because main stresses are not being carried into the strut bracing.

In addition to usual vertical bracing designed to withstand longitudinal or transverse displacement of the top or to stiffen the main legs, when subject to such stresses, bracing in a horizontal plane should be put in to resist warping from torsional loading.

"Flexible" towers, first suggested by the Italian engineer, Smenza, are constructed to be rigid in a direction transverse to the line, and, of course, against vertical loads. These, then, become very effective supports for the line against the vertical dead load of conductors, ice, snow, etc., and also against wind. But by their design they are quite flexible in a longitudinal direction. A distinct saving is thus effected in the weight of these towers by the absence of any longitudinal bracing. As mentioned elsewhere, the tie fastening the conductors to these flexible towers is usually designed to give way under even a comparatively small longitudinal pull, and this obviates the chance of complete destruction of the tower by broken cables. In designing a transmission line with flexible towers the engineer uses one or more of them consecutively—the number depending on span length selected, configuration of the ground, etc., and then one dead-end tower, where all conductors are firmly anchored.

One of the best-known examples of flexible towers in Canada is to be found in the municipal transmission line between Winnipeg and Point du Bois, Man. In this case the engineers—Smith, Kerry, and Chace—have placed rigid and flexible towers alternately at about 600 feet cts. The tie to each insulator on these towers is only good for 80 to 100 pounds before it fails.

It is generally admitted, however, that flexible towers are not quite so reliable as the braced, and it is just a question as to how far their increased economy offsets their decreased reliability.

(b) Cross-arms.—The cross-arms for pin insulators must be very carefully designed owing to the heavy torsional stresses developed in them by the height of the insulator pins. Cross-arms for suspended insulators, on the other hand, have these loads applied almost directly on the arm. Cross-arms should always be designed for about 1,200 pounds suspended at each extremity, for one or two repair men at any time may have to be at the very end of the arm.

(c) Ladders.—A step bolt ladder should always be provided ascending one leg of the tower. It is frequently required that, after passing the first cross-arm, ladders shall be provided on two legs to the top in order to allow use of either corner as a route from lowest cross-arm to top of tower.

(d) Foundations.—The foundations of the towers are, in the main, of two kinds: (1) Steel, with anchor or bearing piece; and (2) concrete. The simplest steel foundation is the single stub angle, in which each leg of the tower is supported by a small angle let into the ground.

(1) The stubs consist of comparatively short pieces of angle, with holes punched in each leg at the tops. These holes match the holes punched in the bottom of the main tower legs. On the other end of the stub angles there are riveted or bolted bearing devices of one kind or another. These usually consist of a piece of 8 in. or 10 in. about 2 ft. or 2 ft. 6 in. long, two angles about the same length or old pieces of I-beams, etc. In practice these foundations are set as follows: Four holes are dug at the proper centres and to the desired depth. Each stub angle, with its bearing piece, is set into the proper hole, care being taken that it rests on undisturbed earth. The foundations are then bolted to a large, full-size template built to duplicate a standard tower. When bolted up in this way the earth and gravel are then backfilled and tamped into position. This style of foundation is fairly satisfactory, except on hard rock, where some type of fox or wedge bolts should be grouted in with either cement or sulphur. The tops should be forged to fit the tower legs, which are then bolted directly to them. Stub angle foundations are not suitable for marsh or swampy lands. Steel foundations may also be of the steel tripod stub type, where each leg of the tower is supported by a complete tripod, to apex of

which is fastened the main angle. The base of the tripod is made up of some simple bearing device in plates, angles, or channels. The uplift capacity of the tripod type is about 50 per cent. greater than that of the single stub.

(2) Concrete foundations are becoming more used in recent years for the large towers supporting long spans. Their supremacy and solidity also recommend them highly for the foundations of special dead-end and angle towers. These foundations are of several types—mushroom without forms, mushroom with steel or wooden forms, truncated pyramid type to forms.

The mushroom type is usually constructed by digging postholes about 16 in. in diameter and about 6 ft. deep. The bottom section is then undercut for a depth of about two feet and to a diameter of about 5 ft., leaving in the upper part a parallel-sided posthole for about 4 ft. Sometimes the spread of the bottom portion is made by dynamite instead of digging. In either case the stub angle or other type of steel foundation is set to template and the concrete is poured. Forms are often hard to set and hold in place owing to their tendency to lift when concrete is being placed. Concrete foundations of type (b) are difficult and somewhat expensive because of the difficulty in setting the forms. This type is satisfactory in service, however, for swampy locations, owing to the large spread that may be given to the base. The anchor bolts are usually set to template before the concrete is poured. The tower legs for these foundations have, of course, small angle shoes to rest on the concrete, and the anchor bolts pass through them. With all concrete foundations care must be taken to effectively ground the tower electrically by some standard device.

The whole question of tower foundations is one that bears a very important relation to the strength of four-legged towers, and it is highly probable that in the past many structures have failed owing to some small uplift of one foundation rather than to any inherent weakness in the structure itself. Every care should, therefore, be taken to ensure rigidity against either upilft or sinking of any one of the foundations. Spread footings in concrete, either of the mushroom type or of the truncated pyramid type, would seem to be the foundation of the future, and the writer would recommend them for class A towers.

The method by which the main horizontal shear is transferred from tower to ground is one that has only recently been investigated. The usual way in the past has been to connect the lower diagonal to the main leg about six inches or one foot above the connection to the foundation. With this device all shear must be taken up by stub angles in both direct shear and bending. This introduces, of course, into the main legs entirely new stresses, with their consequent danger.

Erection.

The field splices should be designed to afford easy shipment for the tower sections. Very often erections must take place in localities remote from the railway, and sometimes there is not even a wagon road to the tower sites. Consequently the pieces have to be transported by pack horse or mule. Under circumstances any thought given to the layout of field splices and weight of shipping bundles is amply justified. Bundles of main material should not weigh more than 200 to 250 pounds. All bolts, nuts, and washers should be boxed by themselves and carefully marked. In the field all pieces are assembled and bolted together on the ground and the tower raised as a unit by some simple tackle, e.g., a gin pole.

Preservatives.

As mentioned under "Depreciation," two main methods of preserving towers are (1) galvanizing, (2) painting. The cost of the former is quite high, and, though it is assumed nominally that no upkeep is required, the danger from unforseen deterioration is very real. If, however, the towers are to be subject to rigid inspection from time to time and provision is made in foundations for either permanency or ability to frequently renew them, there is no reasonable doubt that a heavily galvanized skin is a substantial and almost permanent preservative. The galvanizing should be done on all material except bolts, nuts, etc., after all shop work is completed. All bolts and nuts should be sherardized after the threads are cut. Paint is very much cheaper than galvanizing, but has the objection that it must be frequently renewed. But this can, of course, be done in the field, while galvanizing is always a shop process.

The writer would recommend the adoption of paint as the better preservative for all transmission poles and towers, with the possible exception of those located in regions of difficult access, such as mountainous country.

Limits in Design.

The following structural limits in design are recommended without comment:

For Class A Towers.—No main material less than 5/16 in. thick. No angle leg in a main member to have a greater width than twelve times its thickness. No conductor to be able to come closer than 2 ft. 6 in. to tower except insulator pin and cross-arm (up to 100,000 volts). No bracing member less than 2½ x 2¼ angle. No bracing material thinner than ¼ in.

Class B Tower.—No main material less than ¼ in. thick. No main angle ratio less than 1/12. No bracing material less than 3/16. No conductor to be able to come closer than 2 ft. 6 in. to tower except insulator pin and cross-arm (up to 100,000 volts).

Class C Tower.—No main material less than 3/16. No main angle ratio less than 1/12. No bracing material less than ⅛. No conductor to be able to come closer than 2 ft. 6 in. to tower except insulator pin and cross-arm (up to 100,000 volts).

It is distinctly understood that the writer only recommends towers of class C for adoption under those circumstances that unquestionably necessitate the placing of the project in that class.

The suggested unit stresses, limits in design, etc., for class C are merely to offer a slight guide to obtain towers that shall be as serviceable as possible under very adverse conditions.

Trade Publications

Belts—A monthly booklet issued and distributed free by the Federal Engineering Company, of Toronto, containing information for users of belts. The present issue contains an interesting article on slack belts.

Manganese Steel—The American Manganese Steel Company, Chicago, have issued Bulletin 72, describing their Manganese Steel centrifugal sand and gravel pumps and wearing parts for pump dredges. The bulletin is illustrated throughout.

Personals

Miss Mary Kentner, B.A., of 5 Chicora Avenue, Toronto, will be that city's first woman architect. Miss Kentner is a graduate in modern languages of the University of Toronto, and is now training in the "School" under Prof. C. H. C. Wright.

Mr. R. E. Chadwick, A. M. Can. Soc. C. E., has been appointed eastern manager of the Foundation Company, Limited, Montreal. He has just been on a visit to the Pacific Coast. Mr. Chadwick was formerly chief engineer of the company in Montreal, and later was appointed chief engineer of the United States company, with headquarters in New York. He is a Canadian by birth.

Mr. R. E. Speakman, who has been city engineer of the city of Brandon, Man., for more than six years, is leaving Canada to return to his home in the Old Country. Mr. Speak-

man has suffered severely from rheumatism during the past two years and his friends in England have been urging him for some time to return home. He has been in this country for 25 years and has designed some of the biggest bridges that were built from 1900 to 1910 in the West. He had been city engineer at Calgary previous to going to Brandon.

Mr. Neil G. Beggs, the well-known Toronto architect, has responded to the call of King and Country, and accepted a commission in the Canadian Engineers. His doing so entails a great sacrifice, for he leaves behind him a wife and five small children. Mr. Beggs has been very active in his profession, and has the honor of designing and superintending some of the largest buildings in Toronto. Notable

Lieut. Neil G. Beggs

amongst them stands the Loretta Abbey day school on Brunswick Avenue, which is claimed by many critics to be, if not so large, a more handsome building architecturally, than the new Technical School. He has also designed some of the largest apartment houses in the city—the Ernescliffe, Wellsboro, etc.—and numerous important buildings. Mr. Beggs has announced that his office in the Cosgrave Building will be closed till after the war. Communications of a business nature may be addressed to his residence, 50 Standish Avenue, North Rosedale.

Obituary

William C. Gibb, an old Scotch pioneer, who settled in Amherstburg, Ont., in the early fifties, died recently in that town at the age of 85. In his younger days the late Mr. Gibb carried on the trade of carpenter and builder, in which he was a skilled workman.

Mainly Constructional

East and West—From Coast to Coast

The B. C. Glass Works, Limited, have been incorporated with a capital of $10,000, head office at Victoria, B.C.

According to an official announcement the Quebec Government spent on good roads up to January 1st, 1913, the sum of $1,949,566, and up to July 1st, 1914, the sum of $3,991,722.

The Lymburner Brass Works, Incorporated, have been granted letters patent, with a capital of $40,000; chief place of business, Montreal.

At a recent meeting of the Thorold Engineers' Club an interesting address was delivered by Mr. Andrus on "Ten years' residence in the Balkans and Egypt."

During the fiscal year 1915-16, the Quebec provincial Department of Public Roads paid out the sum of $4,000,700.83 for the construction of provincial and municipal roads, for the maintenance of mud roads, for special work, for small bridges and for cost of administration.

Letters patent have been issued to "La Fonderie de L'Islet, Limitee," to acquire and operate the business now being carried on at L'Islet, Que., under the firm name of "La Fonderie de L'Islet." The capital of the new company is $20,000, and they will carry on the business of foundrymen.

The building figures in London, Ont., for 1916 are very satisfactory and it is stated that by the end of the year the total will exceed $900,000. This compares favorably with any year since 1908 with the exception of 1913 and 1914, when there was unusual activity in the building trade.

A new public school will be completed in Ford City, Ont., early in 1917. This building will cost $40,000. It will contain five rooms and will be strictly modern in every detail. The structure has been laid out in such a way that later on an addition can be built to make it a twelve-room school when the growth of the town warrants such an extension.

The rebuilding of a bridge over the Russel Brook at Lower Derby, N.B., has just been completed. This bridge, which was formerly built of crib work alone, has been filled with stone and earth and riprapped with stone the entire length from the base to the crib. It is 230 feet long at the base, 24 feet wide at the top, and 22 feet high. The riprapped work is built at an angle of 45 degrees, and the hills on either side have been lowered and widened out to a distance of 25 feet. From below the frost line the centre of the bridge is faced with concrete to a height of 10 feet, and through this there is a 36-inch concrete drain pipe. The guard rails are of strong wire and cedar posts. Mr. James Walsh, of Strathadam, was the builder.

The work on the Marsh Road, at St. John, N.B., which is being carried out by the provincial government under the supervision of Engineer A. D. Taylor, has been progressing satisfactorily, and whatever portion of it remains unfinished this fall, will be completed early in the spring. A tractor has been used on this road, which is said to have given very good results. For the month of October the cost of operating the tractor was $450, and with an allowance of $350 for depreciation, interest and repairs, a total of $800 is estimated. It is calculated that this is a saving of $415 in comparison with team work. The work being done is of a semi-permanent nature and can easily be made a part of a permanent highway should it be decided later to build one.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Brussells, Ont.
The Town Council propose to make improvements to the pavement on Turnberry Street in the spring, and may lay a cement roadway. Particulars from Reeve Leckie.

Goderich, Ont.
The Town Council are considering the construction of a sewer on Brittania Road. Particulars from Councillor Wigle.

Hamilton, Ont.
Tenders on the construction of the proposed southwest sewer will not be called for some time. Engineer, E. R. Gray. Approximate cost, $14,000.

The City Council will call for tenders immediately for the construction of a sewer on Rosslyn Avenue. Approximate cost, $33,000. Engineer, E. R. Gray.

Levis, Ont.
A plan for filtration plant has been submitted to the City Council by Ouimet & Lesege, Montreal, and the City Engineer, C. Lessard, has been instructed to make a report on the scheme. Approximate cost, $30,000.

London, Ont.
The City Council are about to build sanitary sewers on William Street by day labor, under the supervision of the Engineer, H. A. Brazier. Approximate cost, $5,000.

Montreal, Que.
The City Council have not awarded any contract for the supply of water meters, but will take the matter up again in the spring. Engineer, T. W. Lesage. Approximate cost, $10,000.

Saskatoon, Sask.
The City Council propose to spend $200,000 on the construction of pavements, etc., next year. Commissioner, C. J. Yorath.

Toronto, Ont.
The Board of Control will receive tenders until November 28th for the installation of a 30-inch belt conveyor and appurtenances at the main sewage disposal works. Specifications at Room 6, City Hall.

CONTRACTS AWARDED.

Vancouver, B.C.
In connection with the construction of the West End interceptor for the Vancouver and Districts Joint Sewage and Drainage Board, contract 5C has been let to H. P. Peterson, foot of Clark Street, at $97,429. Contract 5B will be done by the board, under the supervision of the engineer, A. D. Creer.

Railroads, Bridges and Wharves

Fort William, Ont.
The Canadian Northern Railway proposes to replace their present docks with a reinforced concrete structure, and plans are now being prepared. Approximate cost, $100,000. Head office of the company, Toronto.

Hamilton, Ont.
The City Parks Board have been asked to appropriate $8,000 for the construction of a subway from Dundurn Park to the bay shore, where the Harbor Commission propose to build a beach. City Clerk, S. K. Kent.

Welland, Ont.
The Niagara, Welland, and Lake Erie Street Railway Company, Welland, propose to construct a subway, at an approximate cost of $17,000.

York Township, Ont.
The Township Council are considering the construction of a bridge over the West Don River at Lansdowne Side Road. Plans have been submitted by the Township Engineer, Frank Barber, 57 Adelaide Street East, Toronto. Estimated cost, $22,000.

CONTRACTS AWARDED.

Montcalm County, Que.
The County Council have awarded the contract for steel work required in the erection of a bridge between Ste. Julienne and St. Liguori to the Dominion Bridge Company, St. James Street, Montreal.

Russell Township, Ont.
The Township Council have let the general contract for the construction of a concrete and steel bridge to the Ontario Bridge Company, Crown Office Building, Toronto, at $16,450.

Public Buildings, Churches and Schools

Alliance, Alta.
The Public School Board have decided to postpone the erection of a school until the spring, as the tenders received were too high.

Edmonton, Alta.
The Public School Board propose to build an addition to the Technical School and to increase the capacity of the machine shop. Secretary, F. Brody, Civic Offices.

Hamilton, Ont.
The tenders received for the erection of an addition and balcony at the Barton Street Hospital have been returned to the tenderers, and T. H. Pratt, chairman of the Hospital Board, is receiving tenders informally. Approximate cost, $15,000.

Montreal, Que.
The Roman Catholic School Commission, 87 St. Catherine Street West, are having plans prepared for the erection of two schools on Pie IX. Avenue, one for boys and the other for girls. Tenders will be called early in the new year. Approximate cost, $200,000 each. Architect, C. A. Reeves, 83 Craig Street West.

The architect for the proposed school to be built on Notre Dame Street for the Roman Catholic School Commission, 5430 Notre Dame Street East, is C. A. Reeves, 83 Craig Street West.

New Toronto, Ont.
The following tenders for work required in the erection of a school will be received until noon, November 29th, by T. H. Fountain, secretary to the School Board: (1) Masonry and brick work; (2) carpentry; (3) lathing and plastering; (4) painting and glazing; (5) roofing and galvanized iron work. Plans and specifications at residence of J. Gaunt, Fifth Avenue, New Toronto. Approximate cost, $20,000.

Oshawa, Ont.
Tenders are now being received for the erection of an addition at Oshawa Hospital. Plans with the president, J. D. Storie, and with the architects, Langley & Howland, 112 King Street West, Toronto. Brick construction. Estimated cost, $20,000.

Ottawa, Ont.
In connection with the reconstruction of the Parliament Buildings, tenders on stone for interior work will be received until 4 p.m., December 5th, by the architects, J. A. Pearson and J. O. Marchand, Centre Block. Prices and samples are required of sandstone, marble, limestone, and granite, as well as the quantity that can be delivered per month.

Quebec, Que.
The architects for the proposed school on Salaberry Street for the Roman Catholic School Board are Tanguay & Lebon, 20 d'Aguillon Street.

Sault Au Recollet, Que.
The School Board have appointed L. R. Montbriand, St. Andre Street, Montreal, architect for the proposed school.

St. Hyacinthe, Que.
Tenders may be called soon for the erection of a school for the Roman Catholic School Commissioners, but work is not likely to start until the spring. Approximate cost, $25,000. Architect, G. R. Richer, 10 Cathcart Street, Montreal.

St. Victor De Tring, Que.
J. S. Bergeron, 103 St. John Street, Quebec, is now preparing specifications for the proposed college for D. Caron and J. Bernier, and tenders will be called next month.

Trout Creek, B.C.
Tenders on the erection of a school will be received until noon, November 2th by J. E. Griffith, Deputy Minister of Public Works, Victoria. Plans and specifications at offices of L. Norris, Government agent, Vernon; J. Mahony, agent, Court House, Vancouver; J. L. Logie, secretary School Board, West Summerland, and at the department, Victoria.

Uxbridge, Ont.
The School Board propose to build a

ESTABLISHED 1886

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Clearing House for Contractors' Equipment

A CLEARING house for contracting equipment would, we believe, solve many of the difficulties and complexities pertaining to the present system. That a practical and timely step has been taken in this regard was noted recently in these columns, when it was stated that a committee of the Montreal Builders' Exchange had been appointed to work out the details of a scheme for the exchange of surplus plant, on a rental basis, between general contractors. There is no doubt that the existing dullness of conditions in many trade and industrial departments has provided much used equipment which surely ought to be kept in continuous and useful service by some system of pooling. That such a plan presents mutual advantages is obvious. It repays the one party by reimbursing him for equipment otherwise idle, and it saves the other the unnecessary burden and expense of purchasing plant for perhaps unimportant jobs.

In the present methods there is a waste of effort that has, under the circumstances, perhaps, been unavoidable, but during the present stressed conditions there is a call for mobilization of resources, and, so far at least as the business of contracting is concerned, a clearing house, as suggested, would ensure greater co-operation so that the existing facilities for production might be utilized to the fullest advantage. To provide one instance, it has been suggested that the motor truck and haulage facilities of large contractors, usually idle during the winter season, could be well taken advantage of by the coal dealers for transportation of their product. The merits of such a scheme would appeal to both interests, inasmuch as the contractors would derive a profitable revenue for an otherwise unprofitable plant, and the dealers would be relieved of carrying a quantity of all-year-round equipment for the peak load of but a few months' trade.

It is, however, rather between contractors themselves that such a scheme should find favor, for there are many small firms the extent of whose work does not justify the maintenance of a comprehensive plant who could profitably make use of the surplus or idle machinery of other contractors, and there are large contractors who would be only too willing, for a reasonable return, to keep their machinery in operation rather than bear the expense of its enforced idleness.

* * *

There is another field, too, in which a pooling arrangement ought to be a welcome suggestion, and this is in regard to the machine shop organizations that have been rounded up for munition manufacture. There is evidence of the efficacy of this arrangement in the recent formation in Britain of a Central Clearing House Organization, under the direction of the Ministry of Munitions, which has for its objects, firstly, to ensure that war contracts are directed toward any unoccupied manufacturing capacity which may exist in the country, and, secondly, to place contractors in touch with all departments requiring the help of industry, but generally to assist contractors who are able to undertake additional or more suitable workfi not only now but at a future date, and to render help in maintaining continuous employment of their machinery and labor.

* * *

The experience of Canada's war contract awards shows that there are many firms with ill-fitted factories, and with inefficient labor, resources, and experience who are burdened with a superabundance of munition work, while plants with the necessary facilities are struggling to secure orders, and whose machinery is allowed, without explanation, to remain idle, though this state of affairs, we are glad to say, appears to be righting itself slowly. The clearing house department would have for its first object the direction of contracts to such unoccupied capacity as, within common knowledge, exists aplenty in the Dominion. The better prosecution of the war needs more concentrated efforts on the part of manufacturers and a closer co-operation between the government and the firms engaged in war work and the efforts made in Britain through this new organization can well be duplicated in Canada. In the interests of a victorious termination of the war, manufacturers and government should co-operate to such an extent that the unoccupied facilities will be registered and their resources directed to the most profitable ends.

The second function of the British Clearing House

Organization contains, perhaps, a suggestion, although there is no definite statement in this regard, that a groundwork is being laid for post-war occupation of the country's manufacturing resources. That the government is endeavoring to maintain continuous employment of contractors' machinery and labor and assisting them to undertake additional or more suitable work, not only now, but at a future date, might indicate that it is preparing to assist the industries in the recovery from war shocks and to enable them to bridge the trying gap that will exist between the war and peace periods.

The plan of a clearing house department is an experiment that will, doubtless, if present promise is fulfilled, be evolved into an organization of profound service. The principle is generally applicable, however, not only to national mobilization of industrial machinery, but equally to the equipment and facilities of all branches of trade, and more particularly to those associated with building and engineering.

Engineering Failures

SIR MAURICE FITZMAURICE, in his presidential address to the Institution of Civil Engineers, condensed elsewhere in this issue, adopts a line a little out of the ordinary when he discusses the difficulties, anxieties, and failures that every engineer has to confront, and outlines the obstacles that beset the path to success, for he ventures to state that there is no engineer whose undertakings are of any extent who has not at some time experienced disappointment, failure, or accident.

The one matter that is emphasized is the usual lack of a provision for possible contingencies. Engineers are, in general, too optimistic in the design of their work and in the estimates of cost and time, and yet these underestimates are not always willingly arrived at. The clients do not, as a rule, seem to realize that some provision must be made for the inevitable, and that a sufficient allowance of both time and money must be made if contingencies which may arise are to be met. Much of the engineering work that is being erected to-day is apparently a race against time and money, and the inevitable result of failure will some day ensue. It does not pay to be too optimistic, either as regards design or the estimates of cost and time.

Inaccurate estimates are only a result of the lack of knowledge engineers have regarding the forces of nature. Our information concerning these is continually improving, and will always do so, and in the light of this it is impossible to forecast results or to guarantee against accident. New unforeseen difficulties are always arising which require the development of new methods for overcoming them. On this account the engineer's work has to be based on a co-relation of scientific procedure with experiment, experience, and a proper appreciation and balancing of the inexact knowledge available.

Improvement in Supply Trade Conditions

Recently a decided improvement has taken place in the Montreal building supplies trades. The placing of substantial contracts with Montreal contractors for work in the city and outside points and a revival in building in the province generally, has resulted in good orders for the supply houses. This demand has also been stimulated by a rush at the end of the season to complete work while the weather remains favorable. One of the largest supply firms in the country stated that the orders were, during the last two months, the best since the war, and another firm confirmed this, adding that the out-of-town business was exceptionally good, having regard to conditions. The improvement has occurred notwithstanding advances in practically all lines of material, and the higher cost of labor. The erection of ammunition factories, the extension of industrial plants, and the building of new pulp and power mills, and also additions to such existing plants, together with the building of many churches and schools, particularly in the province, have all helped the supply firms. In the city of Quebec, the building programme has been extensive, many of the structures costing very large sums, while in Ottawa the recent contracts given out show a satisfactory increase.

Valuable Report by the Commission of Conservation

The focussing of public attention in Canada upon the problem of strengthening our national organization through increased industrial and commercial efficiency lends special value and interest to the Seventh Annual Report of the Commission of Conservation, which has just been issued. The activities of this Commission, relating to the entire field of primary production, aim to secure greater efficiency in basic industry—in the development and utilization of Canada's natural resources.

Steady progress has been made by the Commission in the huge task of national stock-taking, the urgent necessity for which becomes daily more apparent. Recent experience has served to emphasize the need for accurate knowledge of the nature and extent of the Dominion's wealth in lands, forests, minerals, water-powers, fisheries and wild life, as a guidance to intelligent and permanent national expansion.

The report, which is bound in cloth, and well illustrated, constitutes an important addition to the literature on Canada's resources and the problems connected with their efficient administration and development.

The grand total trade of Canada, including coin and bullion, for the financial year ended August 31st did not fall far short of the two billion mark. Of the six leading general branches of products exported, agriculture ranks first, being valued at $382,000,000; manufactures come second, with $333,000,000—nearly treble the figure for the previous year. Exports to the United Kingdom were large, the figure being $646,504,000.. This compares with $185,000,000 in 1913. Another big item was our imports from the United States, amounting to $492,483,000, which is $208,000,000 ahead of last year and $50,000,000 ahead of 1913. The enormous scale upon which Canadian steel and metal plants are operating is evidenced by imports of raw metals and the exports of the same in more or less finished form. Imports totalled $128,181,000, against $78,446,000 a year ago. Exports of metal products amounted to $140,055,000, of which $58,363,000 was iron and steel and manufactures thereof. Last year the total was $85,841,000.

Many Big Canadian Factories Under Way

Work Not Being Delayed by Cold Weather—Description of New Methods Employed by Contractors

THE photograph reproduced with this article illustrates the new factory at present being built for William Wrigley, Jr., Company, Ltd., on Carlaw Avenue, Toronto, and represents the state of construction on November 15. The new building is located next to an existing factory belonging to the same firm, and is intended to increase their manufacturing facilities in accordance with the growing demand for their product. In the figure the structure at present in use is shown in the right background. The new unit on the left is at present in process of construction, and will be an exact replica of the old plant turned side for side. The design and finish of the two buildings will be identical. The floor space will thus be exactly doubled.

The new unit is a five-storey and basement structure, 258 feet long over all and with a width of 82 feet in the major portion of the building and a width of 92 feet for the front 40 feet. This addtional 10 feet provides an entrance and hallway on the ground floor, with stairways and passenger elevator shaft. The length is divided into 13 bays of 19 feet 9 inches in length and the width into four bays of 20 feet. A concrete frame is used, with the side and rear faces panelled with brick and fitted with steel sash. The concrete beams and columns that show from the outside are finished smooth. The facade columns are faced with brick, with concrete trimmings. The space between the two buildings will be utilized as a driveway, provision being made for a shipping or wagon drive near the rear of each building.

The design is carried out in the conventional mushroom or flat-slab reinforced concrete type, with circular interior columns and flat-faced exterior columns. There are 73 columns altogether. Wood centering is used for floor forms, with sheet metal forms of the Deslauriers type for the columns. Alabastine hollow concrete blocks are used to form the partitions. In keeping with the fireproof nature of the building, steel window sash and doors will be installed and a sprinkler tank located on the roof. One passenger elevator and two freight hoists are included in the equipment.

Economic Handling of Materials.

The factory is especially favored in its location on a railway siding, so that materials can be handled economically and advantageously. The handling equipment has been devised to facilitate operations and to minimize hand handling as far as possible, and, in fact, from the time the raw materials come in until the concrete is in the forms no hand labor is required. The cars containing sand and coarse gravel or crushed stone are run directly to the site, and a stiff-leg derrick, fitted with a clam-shell bucket, unloads the materials into supply bins. Just at the present time the smooth operation of the handling plant is impaired slightly by the embargo recently placed on freight cars by the railways, which has interfered considerably with the transportation of supplies. On account of this much of the sand and gravel is brought in by wagons, which is not as efficient as under normal conditions when freight cars are available. From the supply bins the sand or gravel, as the case may be, is chuted through a manually-controlled measuring hopper into a skip-car operating on an inclined runway. The car is pulled up the incline and dumps automatically into the mixer hopper, where the cement and water are added. The skip-car runs back to the bins by gravity. The concrete is elevated in a hoist bucket, and is deposited directly to the forms through steel chutes. Besides the concrete hoist there is a brick hoist for the elevation of materials. Both are fitted

Progress on Wrigley factory, Toronto—Photograph taken Nov. 15.

with derricks. These hoists are seen in the illustration. Three hoisting engines are employed. One operates the clam-shell, one the brick hoist, and the third pulls the skip-car and elevates the concrete hoist.

All steel reinforcing is bent on the job, and a power-driven woodworking equipment facilitates the construction of forms.

The mixes used are normally 1:2:4 and 1:1½:3. Pit-run sand is used, as this is rather high in stone, and it means that the coarse aggregate can be cut down a little. This effects a little saving.

Protection Against Cold Weather.

One of the difficulties of the present season is the danger from frost, and special precautions have been taken on this job to ensure freedom from its effects and remove any danger in this regard. Heated materials, as well as the application of heat during setting, constitute the means that have been taken to enable concrete to be poured in the cold weather. Live steam pipes in the aggregate bins keep the material very hot, and hot water is used in mixing, so that the concrete is distributed in a warm condition. The greatest danger is liable to occur during the process of setting, and on this job a special scheme has been evolved to overcome this danger. After the slab has been poured it is ponded with hot water from a continually running hose for a period of 12 to 14 hours overnight, after which the water is drained off. This method appears to give excellent results, and the contractors state that after the hot water is withdrawn the concrete is found to be exceptionally firm, and every danger from frost is removed. The cold weather has not been severe enough to warrant exceptional measures so far as the columns are concerned, but hereafter the walls will be enclosed and salamanders used to reduce the frost. With these precautions, the contractors are ready to cope with any cold weather conditions that may be likely to occur, and they will be enabled to do concreting throughout the winter season. As there are still two floors to pour within the next few weeks, there will be every need for effective measures to prevent frost effects.

Quite rapid progress is being made. One floor is completed in an average of six or seven working days. The concrete for each floor is poured in one day and during the night hot water is ponded over it, as already explained. The progress view illustrated in the figure shows how far the work had advanced at a recent date.

Personnel.

The structure was designed by Messrs. Prack & Perrine, engineers and architects, Toronto, and the work is being carried out by the general contractors, H. G. Christman & Co., Hamilton, Ont. Mr. McMichael is supervizing the construction for the general contractors and Mr. Kaiser for the engineers. The spirals and spacing bars are supplied by the Electric Welding Company, and the other reinforcing by the Burlington Steel Company, Hamilton, Ont.

The estimated cost of the building is $225,000.

Report on Montreal Aqueduct Scheme

Results of Investigation Carried Out by a Committee of Rate-paying Engineers — Findings Are Unfavorable to the Project

THE report of the ratepaying engineers of the city of Montreal on the works now under construction and completed for enlarging the water supply aqueduct and developing hydro-electric power for the use of the municipality, has just been submitted to the Board of Commissioners and to the City Council of that City. Montreal has been supplied with water for many years from an open aqueduct which carries the water from the Lachine Rapids to a pumping station where water wheels formerly, and steam power later, pumped the supply to the city. In 1905, as a result of a shortage of power, the proposal was made by the then Superintendent of Waterworks that the aqueduct be enlarged and the surplus water used for pumping purposes. Later this scheme was extended to develop a maximum of 10,000 h.p., and up to September 1, 1916, the city engineer reported that 58 per cent. of the excavation and 20 per cent. of the retaining walls had been completed by the contractors. The only work performed so far has been at the head race. The tail race has not been touched, nor have the following important component parts of the complete installation, namely, entrance breakwater, head gates, several bridges, power house, and dredging of the river.

From time to time considerable opposition has been offered to this scheme of hydro-electric development by prominent members of the Canadian Society of Civil Engineers, who have felt that the proposition was turning out much more expensive than the city had originally estimated, and the matter was brought to a head in April of the present year, when some thirty independent ratepaying engineers of Montreal signed a memorandum to the city urging that an engineering commission be appointed to report on the cost of the work and to advise to what extent, if at all, the project might to advantage be modified.

By request a delegation of these engineers appeared before the board of commissioners on May 12 this year, and discussed the question after explaining their position as ratepayers and engineers. At a later date a delegation of the ratepaying engineers accompanied by official representatives of various public bodies appeared before the aldermen and commissioners when it was proposed that the rate-paying engineers make a report, without charge, to the city. The engineers accepted this proposal and named a committee to carry out the investigation, the result of which is summed up in the following conclusion. The personnel of the committee of rate-paying engineers was: W. F. Tye, chairman; John Kennedy, Ernest Marceau, J. A. Jamieson, R. A. Ross, Arthur Surveyer, Walter J. Francis, secretary.

Conclusions

1. The capacity of the original aqueduct was sufficient for three times the present population served, if used for water supply only, and not for hydraulic power.

2. The cost of the construction of a filtration plant was the only further capital expenditure necessary to

make the water from the original aqueduct ideal both for domestic and industrial use.

3. With the exception of the filtration plant and the pumping equipment, all expenditures in connection with the present project are chargeable to power development.

4. The power project cannot be regarded as an essential part of a general improvement scheme, because boulevards, parkways, permanent bridges and so forth were just as applicable to the original aqueduct as they are to the present development.

5. The present project has never been properly studied or reported upon as a whole.

6. The project as designed would not safely develop under the best conditions more than 7,000 horse power at any time of the year, and the average output would be actually much less than this.

7. Serious operating troubles due to frazil and and other ice are inevitable. These will greatly reduce the maximum output below 7,000 horse power and may cause complete stoppage of the plant during a more or less protracted period every winter.

8. The minimum capital cost of the project as designed will be $10,600,000. This cost is exclusive of the filtration works or any pumping plant or steam auxiliary plant, or the Cook Construction Company's claims of over $900,000, or an allowance for parking, or the usual allowance for contingencies.

9. Radical changes in design at greatly increased cost would be necessary to even approximate the capacity of the power development as claimed by the city.

10. The minimum capital cost based on the maximum safe capacity of the plant as designed will be $1,515 per horse power.

11. The minimum fixed charges and operating expenses for the power plant will amount to $757,000 per annum.

12. The minimum fixed charges and operating expenses of the power plant will be $108 per horse power per annum.

13. Twenty-four-hour power can readily be purchased in the open market at a figure not exceeding $25 per horse power per annum, and twenty-hour power suitable for pumping for not more than $20.

14. The yearly cost of purchasing the 7,000 horse power, which is the maximum amount of power that the project might develop, would not exceed $150,000.

15. As compared with the purchase of power, this project, if and when completed, would involve a loss of at least $600,000 per annum.

16. The present project should never have been started, and we are firmly of the opinion that all thought of completing it, along the present lines, should be abandoned.

17. If all work were to be stopped at once, the total capital cost to the city would be about $5,200,000, which includes an allowance of $300,000 for boulevards, bridges, fencing and cleaning up, but no allowance for the claims of the Cook Construction Company.

18. The annual fixed charge on this amount of $5,200,000 will be $345,000.

19. The total yearly cost of 7,000 horse power purchased, plus the fixed charges on $5,200,000, would be $495,000.

20. The total capital cost which will be saved by abandoning the present project will be a minimum of $5,400,000.

21. The total annual saving to the city by immediately abandoning the present project and purchasing 7,000 horse power would be a minimum of $262,000.

22. By judicious adaptation of the existing conditions, a limited return may be derived from the expenditures already incurred.

Large Schools Being Erected in Montreal

CHURCHES and schools have formed a very important part of the building programme in Montreal during the season which has just closed. One of the largest girls' schools is now being erected by Durocher and Archambault, contractors, at the corner of Fullum and Amity Streets, from plans drawn for the Roman Catholic School Commissioners by Vandal & Gascon and Venne & Labelle, associate architects. The site is 71 x 140 feet, and the building is an addition to an existing school, although the addition is considerably larger than the present structure. It consists of three storeys and a basement; the foundations are of concrete and the exterior of red pressed and common hard brick and Montreal limestone, backed with terra cotta. The cornice and balustrade will also be of limestone. The frontage of the addition is on Amity Street. There are to be two entrances on Amity Street, and two at the rear, the latter giving access only to the first floor. The front entrances will have granite steps.

The basement contains the janitor's quarters, a kindergarten class, the heating and ventilation apparatus, the latter on the unit system, Tuec vacuum cleaner operated by an electrical motor, and the coal bins. The heating is by hot water.

With the exception of two small class rooms and lavatories, the entire first storey is planned for a recreation room, the floor being tiled. The other storeys are for class rooms, six on each floor, each 24 x 29, one room being fitted up for instruction in cooking. A large corridor will run down the centre of each floor, dividing the rooms into two sections. The partitions are to be of terra cotta and Rockwall type of cement plastering. Maple will be used for flooring, but in the case of the wardrobe rooms English red quarry tile will be laid. All lavatories will have tiled floors and walls. The floors will be of reinforced concrete. Communication with the existing school is to be by means of automatic fire doors on every storey.

One of the two front entrances gives access to the entire building, the other leading to the first floor only. The stairs are of metal with slate treads. Provision is made for a steel framed partition, with wired glass, at the stairway, this reaching from the basement to the top part of the building. The windows on the ground floor will have trussed Kahn sashes. One of the features of the heating system is the use of Sharp rotary ash receivers, by which the ash is collected in a number of receptacles automatically set under the boiler. When filled a certain number of the cans are placed direct on a dump cart, and are returned by the city when the contents have been dumped on the city dump heaps. The system obviates the necessity of handling ashes except to place the cans on the cart. A private telephone system and automatic clocks will be installed. The contract price for the building is $152,500.

Messrs. The Dominion Wire Rope Company, Ltd., whose head office is in Montreal, P.Q., have opened an office in Toronto, at Room No. 108 Mail Building.

Obstacles to Success in Engineering

The Factors That Contribute to Failures—Engineering is a Very Inexact Science — Value of Research Work

IN his inaugural presidential address to the Institution of Civil Engineers (England) on November 7 the newly appointed president, Sir Maurice Fitzmaurice, whose engineering achievements have won for him a world-wide reputation, struck a rather novel note when he discussed the obstacles to success in engineering. Sir Maurice, in pointing out the difficulties confronting engineers, held that engineers are generally too optimistic in designing their work and in their estimates of cost and time. He believes there is a lack of conservatism in regard to both the time element and the provision of a sum to meet possible contingencies. The causes that contribute to failure only serve to substantiate the claim that engineering is not an exact science, and that the work which must be done is dependent on experiment, experience, and a proper appreciation and balancing of the inexact knowledge available. Sir Maurice remarked also on the importance of research work, and ventured the opinion that engineers on this side of the Atlantic are more alive to the possibilities of industrial research than those of the Old Country, but he hoped the recently evolved governmental scheme would result in work of real value. The address is reproduced herewith in a condensed form:

There are two kinds of want of success which I propose to consider—that in connection with works and that in individuals. There is a third class which some of us have experienced—namely, want of success in undertakings owing to the financial arrangements coming to grief; but this class, although very disconcerting to engineers, is not so clearly allied to our profession as the two former.

I do not suppose there are any engineers who have carried out undertakings of any extent who have not had, at some time or other, to lament failure or accident in connection with at least some part of their works. For many years I was fortunate enough to be engaged by some of the great engineers, and I cannot recollect any large undertaking which has not at times caused my chief considerable anxiety owing to accident on some portion of the works, or from alteration in design having to be made on account of unforeseen causes. Since I have been carrying out works on my own responsibility, I have found a similar state of affairs, and I believe all engineers have from time to time experiences of a like kind.

I am not now speaking of great calamities or disasters. I am referring to those misfortunes which happen more or less on all works of engineering construction. Although very often not of great magnitude, they cause the engineer, the contractor, and client great anxiety and disappointment. The engineer in the case of accident causing loss of life, even though it may be in connection with temporary works for which he is not directly responsible, feels it very keenly, and probably thinks he might have taken, or caused to be taken, some precautions which would have prevented it. Although even a serious accident on works may not entail any extra cost to the engineer's client, it may necessitate such an addition to the time of construction as will seriously dislocate arrangements, made for the use of the works, and may in that way be a cause of serious financial loss.

The necessity for alteration of design, or part of design, owing to unforeseen difficulties, is generally a matter which causes much anxious thought and trouble to engineer and client. Unfortunately, alteration in design is generally accompanied by increased cost and time. In exceptional cases unforeseen difficulties may necessitate abandonment of the work.

The question arises: Are engineers, as a rule, too optimistic in designing their work and in their estimates of time and cost? This question, however, only deals partially with the class of failures I am considering, and before going further I want to clear the ground in connection with one important point.

Contract Difficulties.

Works of any size are generally carried out by contract, and the contractor employed has a very important bearing on the question. Probably every engineer would like to choose as contractor for any work which he has to undertake that firm which has previously carried out similar work for himself or for engineers he knows. This course is, however, one which cannot be adopted, except in a few special cases, owing to obvious reasons.

As is well known, there are two ways of obtaining contractors for works—either by open tender or by asking selected firms to tender. In the first case it is generally understood that it is quite allowable not to accept the lowest tender if the firm has not the necessary experience and standing. There are, however, very often considerable difficulties in rejecting low tenders of unsuitable firms, and explanations to clients are often difficult. I have had experience of a firm tendering for work approximating in value to five million dollars who had no experience of the class of work tendered for, but whose financial and other references were good. Fortunately the tender was passed over. Later on, when the same firm obtained a small contract for somewhat similar work, amounting to about $175,000, failure took place before the work was two-thirds completed. I only mention this as an example of some of the difficulties which arise in open tendering. It is often very difficult to judge of the financial position and the capabilities of a firm of which one personally has no knowledge. Sometimes those who are given as financial and general references seem to rather more than stretch a point in favor of the firm enquired about, or the answers given are so vague as to be useless.

Tenders from Selected Firms.

It might be considered that all difficulties could be avoided by asking selected firms to tender, and in such cases it is generally understood that the lowest tender will be accepted. The procedure is, however, often not satisfactory. It frequently happens that the client wishes to include in the selected list the name of a firm who has carried out to his knowledge some work in a satisfactory way, although of quite a different character to that being dealt with at the time. This is often

the cause of great trouble to client, engineer, and contractor.

We all know contractors whom we would cheerfully accept without any question of reference—firms who at an early stage of the work recognize the necessity of a good staff and of providing all necessary plant, and who know that the initial cost thereby incurred is more than regained by the facilities obtained in carrying out the work and by saving resulting from curtailment in time of construction. It is probably due to the well-deserved profits made by such contractors that other firms without the necessary capital or experience are frequently tempted to tender for work which they are not capable of carrying out with satisfaction to the engineer or his client, or with profit to themselves.

It must not, however, be assumed that I am favoring in all cases the employment of the large contractors. I have had considerable experience with contractors in quite a small way of business who carry out the smaller contracts entrusted to them in a thoroughly satisfactory way, especially when they have laid themselves out for only one or two classes of work, when the principal can give personal attention to the matter, and when they resist the temptation to embark on undertakings beyond their capacity. Some of my most pleasant experiences in engineering work have been with such firms.

I do not know any more unpleasant position, both for contractor and engineer, than when it is evident that a contract is being carried out at a loss. In such cases the contractor, on the one hand, may be forced to carry out the work in a slow and unsatisfactory way, and the engineer, on the other hand, feels that he cannot well press the contractor to spend more money on plant and staff.

I have very shortly mentioned these difficulties with contracts as they are a source of real trouble, but I think I ought at the same time to acknowledge the great help which engineers obtain from many contractors. I consider that one of the most pleasant features of our profession in this country is the friendly and helpful feeling which generally exists between engineers and contractors.

Engineers Are Too Optimistic.

I now come back to the question whether engineers, as a rule, are too optimistic in designing their work, and in their estimates of cost and time. On full consideration of the matter I am inclined to think that we must sometimes plead guilty to this charge, although the optimistic view and underestimates of cost and time are not always willingly arrived at. I do not know whether my experience on this point is the same as that of other engineers.

I am well aware that even in works where all the details have been worked out with the greatest care, where unit prices have been carefully scrutinized, where the different stages of the work have been well thought out, where all possible local information has been obtained, that even then it is necessary to provide a sum of money over and above the detailed estimate to meet any contingencies which may arise, and to make some addition to the estimated time for construction. In some cases, when adopting this course, I have been met with the statement, particularly when dealing with some government or municipal authorities, "You surely, if the design has been properly gone into, do not require that large sum of money for contingencies"; or, "Surely you can cut something off the estimate for time of construction." One then explains the reason of money for contingencies and the added time for construction. After some discussion, the client says: "Well, what it comes to is that if everything goes well the contingency money might be materially decreased and the time for construction reduced, and I would prefer that we took the risk of cutting both down." The engineer knows from experience that such a course is not wise, and that if things do not go right the conversation will probably be forgotten, but very reluctantly finds himself forced in some cases to reduce his estimate of money and time.

Why Are Estimates Exceeded?

What are the reasons why engineers frequently find that their most carefully made estimates of both cost and time are exceeded? The principal reason is, I think, given by the hackneyed but true phrase which we often hear, that engineering is not an exact science. We are continually finding out more about the forces Nature, but as long as the world exists we shall not find out sufficient to enable us to make exact estimates of time and cost, and guarantee works against accidents.

What, shortly, are the principal matters which cause us trouble? The first one, in my opinion, is the small knowledge we are able to obtain of the conditions which exist below the surface of the earth, on which everything has to be founded; secondly, the risk which it is necessary to undertake as regards conditions of weather while works are being carried out; and, thirdly, the varying quality of many of the materials we have to deal with. There is a fourth matter, which affects contractors more than engineers—namely, the difficulty of estimating the cost of materials and rates of wages for a long time ahead. This last also substantially affects engineers' estimates when there is a long interval between the time when the estimates are made and that when tenders are received.

Sir Maurice discussed these factors in turn. In regard to the first—underground conditions—he stated that borings in many cases do not form a basis for a just estimation of the ground, and the fact is that all we have is a rough idea of the nature of the ground at the exact spot where the boring was made and that in many instances very different information would be obtained 50 feet away in any direction. It is quite obvious that borings cannot be made at such close intervals as will disclose, as far as borings can, the nature of all the ground which has to be dealt with. Borings, too, disclose very little information as regards the quantity of water which may be met with, the dealing with which may be a very important item, both in the cost and time of the undertaking, nor do they afford any accurate data regarding the effects of earth pressure, about which there is much variance of opinion. Long experience in such cases, says Sir Maurice, is the principal base to work from, but, even then, considerable latitude is left to the personal factor or even to the imagination of the engineer.

The Risks of Weather.

The war of the elements is another very real obstacle to the obtaining of exact results. The hazards of heavy storms are well known—for example, in connection with harbor works, when the work of months may vanish in a few hours. It is not, however, only unfinished works which suffer. We can probably all bring to mind finished works which have stood for years and have eventually been overcome by storms of exceptional fury. In some cases failures of such completed works are not due to any initial mistake in design, but are owing to the fact that the inevitable rav-

ages of storms for many years have not been dealt with as they occur, and that, in fact, maintenance works have been conspicuous by their absence.

There are other matters affecting not only the estimates of cost and time, but also the utility of engineering works, which are due to the impossibility of being able to arrive at exact conclusions on many points which arise.

A cause of occasional failure in temporary works is due to the fact that engineers and contractors sometimes take deliberate and justifiable risks in connection with such works. In many cases of temporary works where risks are taken deliberately, the cost of reconstructing such temporary works, should failure occur, might only be a small portion of the cost involved if the works were constructed in a more solid manner, and in such cases the risk is fully justified.

Engineering Not an Exact Science.

Perhaps, continued the speaker, I have said enough in this rather melancholy recital of some of the difficulties which engineers have to contend with to show that the common saying that engineering is not an exact science hardly goes far enough to show how inexact a science it is. Although much of the work of an engineer is based on strictly scientific procedure, it is to a great extent dependent on experiment, experience, and a proper appreciation and balancing of the inexact knowledge available.

It is, under these circumstances, hardly to be wondered at that estimates of cost and time of construction are not always accurate. Although it is not possible to draw any very close deductions from different tenders submitted by competent contractors for the same work, owing to the fact that one contractor may happen to have in his possession the necessary plant, may have some special facilities in a certain locality, or may have a particular reason for wishing to keep some of his staff together, still the great diversity in the amounts of tenders received from capable and experienced contractors, after making allowance for these matters, is only a very practical confirmation of the fact that exact estimates of time and cost are impossible.

The difficulties I have mentioned, and many others, are, however, the reason why our profession is such an extremely interesting one. New unforeseen difficulties turn up every day, and new methods are being continually found out for dealing with them. Engineering works, after all, have to be carried out, and engineers and contractors have to design and construct them to the best of their ability.

Research Work.

It is difficult to make any suggestions to facilitate our work, but it has occurred to me on more than one occasion that our brother engineers in the United States and Canada devote more time than we in Britain do to preliminary work and studies, particularly in the case of large undertakings. They appear in some cases to have taught their clients that time and money spent on very full investigation and preliminary studies give a very good return on the expenditure. The governments of Canada and the United States are also not averse to collecting information about rainfall, river discharges, and other matters, which information is at the disposal of those who wish to avail themselves of it. If we could prevail on our clients and on our government to take similar views, they would also find that the money was not wasted. We are, however, as things stand, dependent to a great extent on experience and private investigation and experiment for the success of many of our works. We ought not, at the same time, to forget the great obligations which we engineers are frequently under to chemists, geologists, metallurgists, meteorologists, and others, for the great help which they ungrudgingly give us.

I hope, however, that the government "scheme for the organization and development of scientific and industrial research," which has recently come into existence, and which has already made a grant to this institution for research work, may be a real help to engineers. The scheme in its main features is one conceived on broad and patriotic lines, which may lead to results even greater than were anticipated by those who framed it. As far as I know, the detailed arrangements under which it will be administered have not as yet been definitely laid down. Some, but not all, of the industries which may expect help are at the present time so engaged with war work that it is not possible for those controlling them to fully consider, much less to carry out, useful research work. Such work, to be of real value, must be undertaken in consultation with the different industries. It is, however, important that some definite lines for the working of the government scheme should be laid down at an early date. I hope and believe that it may be developed on such broad, liberal, and generous lines as will command general confidence. If worked on such lines the scheme will be of great value. "A great empire and little minds go ill together."

Types of Floors and Floor Construction*

The types of floor construction most commonly found in the modern buildings are as shown in Figs. 1 to 5, inclusive. These sketches are by no means intended to cover the entire range or even include all of the common types. They show, however, in the opinion of the writer, the more common.

The essential features to be considered in any floor construction are strength, stiffness, durability, fireproofing qualities, light weight, small depth, and the cost. The construction of high buildings demands that the dead weight and the depth of the floor be reduced to a minimum, consistent with good construction and the cost. In recent years, various new types of floor construction have been placed before the designer, and improvements have been made in the older types with the object of accomplishing these results. The forms used for concrete floors are also an important factor, and have been subjected to much study and some reduction in the new types.

The partitions of office buildings are subject to continual re-arrangement to suit different tenants, and the floor, therefore, should be designed to permit a partition to be placed in any position. This requirement is usually satisfied by assuming a certain weight

* From a paper by Mr. F. Ruchti before the Western Society of Engineers.

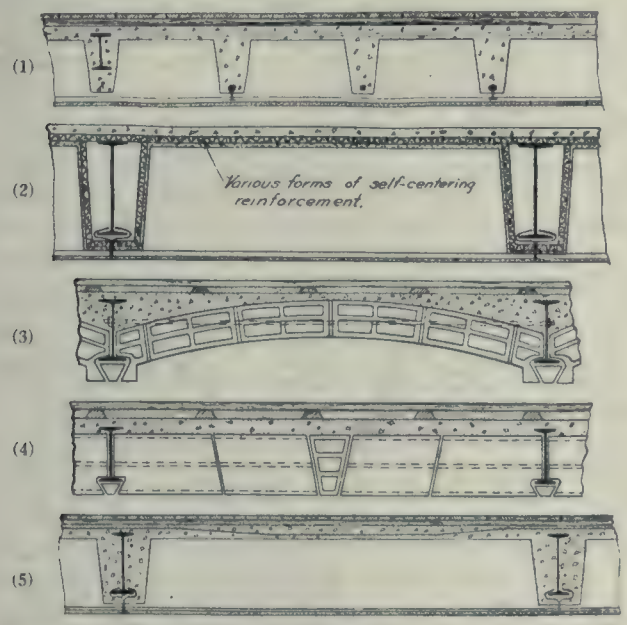
(10 to 25 lbs. per square foot) for partitions and adding this to the dead load of the floor.

Flat ceilings are also desirable, and this requires the use of suspended ceilings for some of the types of floor construction. Ample fire protection should be given the beam on both flanges.

This paper does not attempt to discuss the relative advantages and disadvantages of various types of floor construction. The firms most interested have been quite successful in presenting the respective merits of their particular type and the designer must investigate these claims and make his choice accordingly.

The arrangement and the spacing of the floor beams are influenced by so many conditions, such as location of openings, the locations where comparatively deep beams are permitted, etc., etc., that it is impossible to suggest a particular set of rules to be followed.

The columns having been located and as it is desirable in all cases to transmit the floor loads as directly as possible to the columns, the main panels will be determined from this consideration. The economic-



Figs. 1 to 5—Types of floors most commonly used in modern buildings.

al span of the type of the floor construction will limit the size of the sub-panels. Thus, for terra cotta arches the usual span is from 5 feet to 6 feet; for reinforced concrete slabs the span will probably be larger, but not to exceed 8 feet to 9 feet; while for the concrete joist construction no intermediate panels will be required, as this construction may safely be used for spans up to 26 feet or 28 feet.

For large stretches of floor surface the arrangement of the beams may be influenced by the desire to give continuity to the floor construction. Also, usually there will be a number of floor beams in the panel and only one girder, and as the clearance may limit the depth of the girder, it may be desirable to run the beams in the long direction and the girder in the short direction in order that the latter may not become too deep. Another factor which may determine the direction of the girder is the wind bracing, which may require that the deep girders run in the small direction of the building in order to obtain the advantage of the stiffness of the deep girder connections.

In all cases, however, it should be the aim of the designer to make as many panels equal and rectangular as the general plan will permit. This will give duplication in the structural steel, concrete forms, and terra cotta blocks.

Beam to beam connections are made, in most cases, by simple web connections. These may consist of one or two angles, or in skew connections of bent angles or plates. It will be necessary at times to make a connection by resting one beam on top of another, in which case it may be necessary to investigate the webs of these beams for buckling resistance. Beams framing into shallower ones should be avoided, as this requires large cuts in order to clear the flanges of the shallow beam.

Unnecessary coping and blocking at the ends of the beams should be avoided, and this may be done in many cases without injuring the construction in any way. For instance, very often the floor beams are not as deep as the girders into which they frame. By placing the beams at a slightly different elevation than the girder (1 in. to 1½ in.) connection may be made without any cutting. Holes in both flanges and the web should be avoided where possible and only one size of hole should be used in any one beam. The cutting of beams and the punching of two sizes of holes in a beam, while of small importance in the design of the building, increases the cost of fabrication considerably, and may many times be avoided by a little thoughtfulness in designing.

Beam to column connections are probably most satisfactorily made by using top and seat angles, with stiffener angles if required by the load. This type of connection for the usual sizes of rolled beams is capable of transmitting a larger moment than the web connection and is, therefore, most desirable for wind bracing.

In many cases the clearance lines will not permit the use of stiffener angles. In such cases simple web connections must be used. A satisfactory wind bracing connection may very often be made by the use of web connection angles with top and bottom seat angles.

When a shallow beam frames into a deep beam, this should be carried on a shelf angle and a side connection angle instead of the usual web connection. This connection is an advantage to the erector, as the shelf angle acts as an erection seat, thus facilitating the erection. This is especially noticeable when two small beams frame opposite each other. The smaller beams thus become plain punched beams without riveted connection angles and take a lower classification and a less unit cost.

Mr. R. J. Durley, M. Inst. C.E., consulting engineer, has taken over and will carry on to completion, the unfinished work in Canada previously handled by the Montreal office of the firm of MacMullen, Riley & Durley, which was recently dissolved. He will continue to practise as a consulting engineer under his own name at 4 Beaver Hall Square, Montreal, specializing in the design and construction of power plants and industrial works, in addition to the design of the complete mechanical and electrical equipments of large buildings.

Mr. Raymond Carey announces that the partnership existing between Mr. John Woodman and himself under the style of Woodman & Carey, at Winnipeg, has been dissolved, and that he is now carrying on the practice of his profession at No. 300 Quebec Bank, Winnipeg. Mr. Carey desires catalogues of architectural supplies from Canadian manufacturers.

A Town Planning Act Under Consideration for Quebec Province

The Quebec Government has appointed a small committee to confer with Mr. Thomas Adams, town-planning advisor to the Conservation Commission, on the subject of drawing up an act on town planning. This announcement was made at a meeting held at the Windsor Hall, Montreal, on November 20, to promote town planning in the province, the gathering being the first of several which will be held in the province as part of an educational campaign having for its object the passing of legislation. The meeting on November 20 was largely attended, with representatives from many associations.

Dr. J. E. Guerin, president of the Civic Improvement League, referred to the appointment some years ago in Montreal of the Metropolitan Parks Commission, which had remained a dead letter owing to the fact that its provisions were optional. The opposition to the commission arose from the fear that great cost in acquiring spaces would be incurred, although the tax could not exceed one-eighth of one per cent. of the valuation. The province should prepare for the great influx of population which would come after the war, and the municipalities ought to seek authority from the Legislature to prepare town planning schemes.

A Town Planning Act for Quebec

Mr. Thomas Adams, in the course of an exhaustive address dealing with town planning, said:

A town planning act will assist in improving the settlement of land in both rural and urban districts. Quebec has been successful in maintaining a higher percentage of rural as compared with urban population, than any other province in Canada, having regard to the period during which it has been settled. That success has been due largely to the same planning methods originally employed in the province to secure comparatively close settlement of rural population. Quebec should hold fast to those methods and prepare village planning schemes, with the assistance of a town planning act on all new agricultural territory. The benefit of this closer settlement is seen in the greater ease with which Quebec has been able to carry out its good roads policy—as closer settlement means fewer roads—and lesser quantity of roads means better quality. Rural prosperity is the foundation of urban prosperity and Quebec is demonstrating this in an exceptional degree. Town and country planning and good roads will help to maintain and improve that position.

But whatever rural progress may be obtained the increased growth of urban population is inevitable. It is futile to try to prevent such growth. But while cities and towns must continue to grow, they need not continue to be unhealthy if we plan them right, and prevent bad conditions being created. We need a town planning act for that purpose, an act which will enable us to prevent waste, unsanitary conditions, overcrowding, traffic congestion, destruction of natural beauty and other things that can only be economically secured by planning in advance.

We always plan our houses and factories but not our cities, and yet for every reason we have for planning a building—a simple unit of construction—there are ten reasons for planning a city or town—so complex and interdependent are all their parts.

On the whole, Quebec cities and towns are economically managed, even the much criticized Montreal has nothing to be ashamed of compared to Toronto, from a financial standpoint. Indeed, I think Montreal is in the stronger position. But Montreal, more than any other city in Canada, needs town-planning. She is surrounded by a number of satelite towns that need to be brought into co-operation under a comprehensive scheme for the purpose of lessening extravagance in local improvements, securing higher standards of sanitation, more air space around buildings, less congestion of the centre and closer settlement in the suburbs, a sounder system of land valuation, and a more equitable basis for taxation, more convenient means of transportation, better facilities for carrying on industries, protection of the amenities of residential areas, and more scope for recreation and enjoyment of natural beauty.

An act is required to accomplish these things, because municipalities need greater powers to enable them to do them effectively, and because public interests have to be protected in a greater degree, without injury to legitimate private interests. Provincial oversight over town planning is also necessary, since provincial highway planning must precede city planning, and one city or town cannot be planned alone, it must be planned in co-operation and simultaneously with the surrounding territory under separate jurisdiction. Then the province can and should employ expert advice to help in preparing schemes which the small municipalities cannot afford to employ themselves. Expert advice is as much needed to help on the execution of the scheme as in its preparation, and thus continuity is needed. The legal provisions of a scheme are almost more important than the paper plan of an area, since they determine the principles on which it will be carried out. These are all reasons why town planning can only be made effective if we get the legal basis for its operation.

The act proposed for Quebec has been framed after experience in Great Britain and in the Province of Nova Scotia and New Brunswick, Alberta and Manitoba. It is unlike the Nova Scotia act in that it is not mandatory, but it is otherwise an improvement on the other acts. The following is a precis of its provisions:

Part I.

1. A department of the provincial government has to be named to work the act. It has to draw up procedure regulations, authorize preparation of schemes, approve schemes when prepared, decide differences between different municipalities and owners. Co-operate with highway department of province in securing that provision is made in schemes for main highways, etc.

2. The department has to appoint a controller of town planning who may be an existing official.

3. Every council must appoint a local board, but may have the majority on the board.

Part II.

1. All subdivisions, etc., have to be approved by the local town planning board.

2. Board may require main arteries to be 100 feet in

width, but must purchase land for any greater width. As a setoff to owners secondary streets may be permitted to be 40 feet or even narrower.

3. Readjustment of boundaries of the states may be required.

Part III.

1. Municipalities **may** prepare by-laws or schemes.

2. Scheme becomes act of parliament when finally approved, and cannot be revoked or varied without consent of the provincial department. It may extend into more than one municipal area. Municipality **must** give limited amount of funds to local board to prepare scheme, but has complete discretion to refuse funds to execute scheme.

3. If owner does anything to contravene a scheme the municipality can remove or pull down without paying compensation, but owners have to be consulted at all stages.

4. Compensation clauses provide for **full** payment in case of injury either in making or executing scheme, unless in cases referred to in Section 21, i.e., cases where the department decides it is reasonable that certain restrictions should be imposed in the interest of health and amenities—such as restrictions securing air space, limiting height of buildings, prescribing factory and residential areas, etc. Such decision prevents claims for compensation.

If a scheme improves an area the municipality can claim half the increment of value.

Part IV.

1. Municipality may expropriate land, including land within 200 feet of land acquired for street or park.

2. Price should be fair market value of land.

Part V.

1. Only when a municipality refuses to act **and after a petition from** the taxpayers and **after** a public hearing may the provincial department call upon the municipality to prepare a scheme.

Schedule A. In A it is sought to provide that buildings will not be erected nearer to each other than from 80 to 120 feet on either side of a road, according to circumstances. While main thoroughfares are increased to 100 feet, secondary streets are reduced to 40 feet, instead of 66 feet, but all subject to above building line.

The density of building is prescribed as 75 per cent. of lot in city areas, and 50 per cent. in suburban and rural areas, with a percentage of 90 and 60 respectively on corner lot.

Narrow non-traffic carriage drives are permitted (24 to 28 feet wide) on streets so long as wide building lines are secured.

Noxious trades and unsightly advertising can be prohibited in residential areas.

When town-planning schemes are prepared under such an act capital invested in building can be protected. Fire risks and fire insurance can be reduced. Land values can be put on the most stable basis. Better facilities for manufacturing can be obtained, extension of tramways system can be effected on better principles, and at less loss to the public, and the tramways interests. Real estate can be benefited and the public health can be conserved.

There is no better way than this to lay the foundation for the new growth of population after the war. No more patriotic duty we can perform in the interests of the country and of the returned soldiers. As men make the city, so will the city make men, as the city is, so will our national life be. To make it a better place to live and work in, is a patriotic duty of the highest order.

Discussion

The chairman said that one of the most vital clauses was that giving the right of municipalities to expropriate 200 feet on each side of any property expropriated. This land could then be resold for the benefit of the municipalities.

Dean Adams moved the following resolution: "Whereas, in the Province of Quebec, there is need for improvement in the methods of developing land for purposes of building, in cities, towns and rural municipalities; and for the better regulation of such development so as to secure greater economy in respect of local improvements, proper sanitary and hygienic conditions, more convenient means of transportation, and preservation of natural beauty; and—

Whereas, such improvement and better regulation can be made most effective and can be carried out at least cost and without interference with legitimate interests in property by means of town planning schemes; and—

Whereas, the municipalities of Quebec require additional powers conferred upon them, subject to some provincial authority in respect of the exercise of such powers, to enable them to prepare such schemes; be it

Resolved by this conference, that a petition be forwarded to the Government of the province requesting them to consider the urgent importance of conferring the necessary powers on municipalities, and of passing an act for that purpose during the current session of Parliament."

Lieut. Col. J. Adami, M.D., who has just returned from the front, spoke of the Canadian soldiers in the hospitals being the best emigration agents the country could have. From what he had been told by the soldiers and the Tommies, it appeared they were convinced that the Tommies would not want to return to their old hum-drum life; a vast mass would come to Canada at the end of the war, and the Dominion must prepare for the best class of emigrant the country could obtain. He had been struck with the change in Great Britain since the passing of town planning legislation. It was important that they should get powers of expropriation, in order that the municipalities might be able to recoup themselves for the outlay on schemes.

Dr. Grace Ritchie England inquired whether provision was made in the Bill for sanitation, water and sewage.

Mr. T. Adams replied that there was no better way to deal with sanitation than to plan for it in advance—to lay out town planning schemes. Remedial measures, after the evil existed, were costly, owing to vested interests.

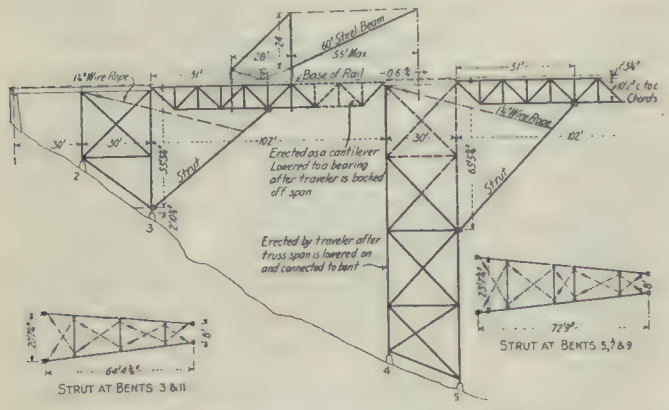
Mr. Gustav Francq, secretary of the Trades and Labor Council; Mayor Beaubien, of Outremont; Mr. W. D. Lighthall, secretary of the Canadian Union of Municipalities; Ald. McLagan, of Westmount; Mr. J. Duchastel, president of the Dominion Good Roads Association; and Mr. J. Bradford, community secretary of the Y. M. C. A., also spoke, accepting the main principles of the bill. Two or three of the speakers also urged the necessity of the appointment of a Provincial Department of Municipal Affairs, in order that special attention could be given to matters of this kind.

The resolution was carried unanimously.

The Ottawa branch of the Canadian Society of Civil Engineers held their second luncheon of the season on November 23 in the Chateau Laurier. Sir Wilfrid Laurier addressed the branch on the subject "The Engineer in Canada."

Special Struts Eliminate Falsework in Bridge Erection

A UNIQUE system of bridge erection was developed in connection with the viaduct illustrated herewith. The special feature that distinguishes the methods employed on this structure was the elimination of expensive falsework by the use of specially designed steel struts and guy cables that permitted rapid and economical erection of the truss spans, without the necessity of the usual temporary supporting falsework structure. The viaduct is of steel, 680 feet long and 170 feet high at the centre and serves for the transportation of coal-mine cars across a deep valley. The structure consists of four towers, 30 feet wide, and three deck truss spans,



Arrangement of struts and methods of erection to eliminate expensive falsework.

102 feet long, with 30 ft. plate girders from the end towers to the abutments. About 340 tons of steel are involved. This design was advocated instead of an originally proposed design involving plate girders and shorter spans on account of the reduced number of towers. On account of the use of truss spans and the fact that all the material for the viaduct, as well as the erection equipment had to be transported long distances to the site, it was decided to use a light timber traveller which necessitated erection piece by piece, a method that normally calls for falsework.

To overcome the expense attending such operations special inclined struts on booms were designed to facilitate the erection of the deck truss spans. The lower ends of the struts were pin-connected to temporary wing plates bolted on the columns of the main towers. The top ends were held in position to hold the bottom chords of the truss spans at their mid points by 1¼-in. wire cables. Fig. 2 illustrates this clearly. The traveller was a light timber affair with a 60-foot steel boom, arranged so that material could be delivered on push cars underneath the frame and carried forward to a position to be handled by the boom.

In constructing the bridge, after the first tower had been erected and the plate girder spans set, the erection struts were attached to the tower columns and guyed in position to receive the centre panel point of the span. The one-half of the truss span was built out to the upper end of the strut, the traveller was moved forward and the next tower partly built up to receive the truss. The remainder of the span was then built as a cantilever. The traveller was backed off and the cantilever lowered to a bearing on the bent, after which the traveller erected the remainder of the tower and operations proceeded as before throughout the whole length of the structure. The lengths of the struts were designed to provide the desired camber in the truss spans and the last sections of the top chord were placed without difficulty.

A material yard was located adjacent to the end of the viaduct in which the air plant was set up. The entire bridge was erected in 34 working days. We are indebted to the Engineering Record for the details of this work.

What Is Filtros?

Filtros, the material so widely used in the floor of sewage disposal tanks, separating the sewage from the air and allowing these to become mixed only in the proper proportions, is composed largely of a pure crystalline silica, carefully ground and screened. This material is mixed with a small proportion of an artificial compound silicate. This mixture is then moistened and subjected to high pressure in die machines of suitable size. As a final process the plates are subjected to high temperature in kilns for several days. The final product is white in color, very hard though flocculent in surface appearance, porous to both gases and liquids and is used for a variety of physical separations.

Filtros is unaffected chemically by all the common acids and most other corroding substances. It also withstands high temperatures and, if corroded, is easily cleaned. It is made in standard sizes 12 in. x 12 in. x 1½ in. thick, which have a weight of 11 pounds each. Special sizes and forms are, however, obtainable.

A Simple Adjustable Shore

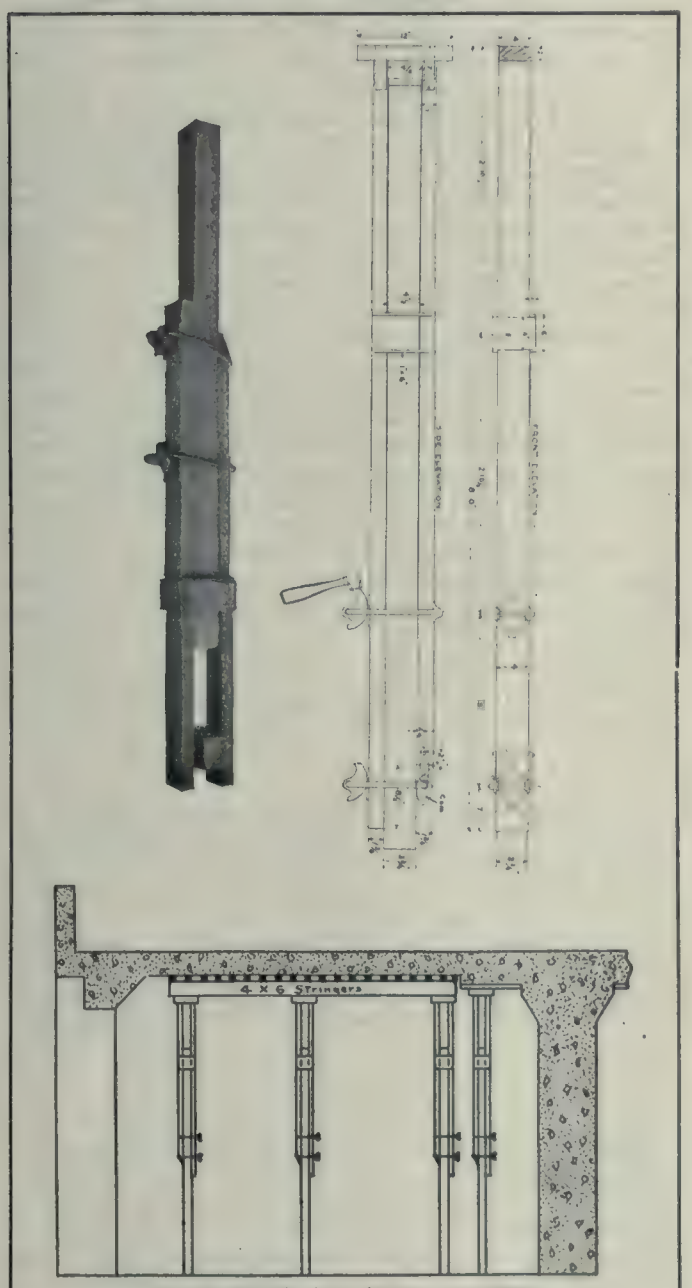
The Ferro Concrete Construction Company, of Cincinnati, Ohio, is continually making improvements and seeking new inventions by which they can improve their work or cut down its cost. An invention which one of their superintendents, Mr. Hodges, recently hit upon and known as the Hodges Adjustable Shore, has already enabled them to make very material decreases in their form costs. These shores are used to hold up beam forms and floor forms, or in any other way that shores are ordinarily used on a concrete building job.

The construction of this new adjustable shore is simple. Three pieces of lumber are required. Experience and tests have proven that the following dimensions are the most satisfactory, and if the shore is made from these dimensions it is even stronger than a rough 4 by 4 inch shore of the same length. The lumber should preferably be No. 1 common long leaf yellow pine, two 2 by 4's planed to 1¾-in. and one 4 by 4-in. planed to 3¾-in. by 3¾-in. All three should be about 8 feet long. In addition to this lumber, which is assembled in accordance with the illustration shown, two special clamps are necessary. These operate by a small blow of the hammer, and fasten the three timbers into a rigid non-collapsible member which can be nailed to or braced at any point desired. The shore is instantly adjustable from 8 to 14½ feet.

The shore is sometimes made with a slotted head, and this type has certain advantages over the one shown in that it can be set up without any nailing or cleating whatever, and cannot fall down when struck or jarred. Neither type will collapse under load as can be readily seen by studying the action of the cams.

In operation the shores are brought from the stor-

age pile and deposited wherever needed on the job. The clamps are loosened and the 4 by 4-in. timbers drawn out to the desired length, this being determined by a measuring pole in the usual manner. The clamps are then tightened, the shores are raised and the stringers placed in position. Intermediate shores can be put into place without careful measuring and after the decking is on, can be levelled up by means of an engineer's level and shore jack in a fraction of the time which is usually required with wedges. With the Hodges shore wedges are unnecessary.



A new adjustable shore showing appearance, construction and manner of use.

According to the experience of the Ferro Concrete Construction Company in using these new shores, it seems that from ten to twelve cents can be saved on each shore every time it is used. Not only is there a tremendous saving in waste lumber, but on account of freight rates, the actual cost of the lumber used in these shores is less than the cost of rough 4 by 4 stock for common shores. Inasmuch as the cost of formwork represents a considerable part of the cost of concrete construction, any savings that can be made on formwork materially affect the cost of concrete buildings.

Brisk Building Conditions in Montreal and Vicinity

MONTREAL contractors have lately found trade more brisk. Business within the city proper picked up to some extent, especially towards the end of the season, and contractors have been fortunate in securing a considerable amount of outside work. The most important of these jobs are the restoration of the Parliament Buildings, Ottawa, in the hands of P. Lyall & Sons Construction Company, Ltd.; the plant of the International Nickel Company of Canada, Ltd., at Port Colborne, Ont., which is being constructed by the Foundation Company, Ltd.; the arsenal at Lindsay, Ont., now being built by Westinghouse, Church, Kerr & Co., and the St. Maurice River dam, by the St. Maurice Construction Company. Then the Purdy & Henderson Company, Ltd., have a large contract for a sulphite plant at Merritton, and the F. J. Jago Company, Ltd., the Raymond Pile Company, and other firms have smaller contracts in towns outside Montreal. During the last fortnight some important orders have been given out for Montreal work. The Atlas Construction Company have secured some nice contracts, including those for the new Loew theatre, the addition to the plant of the British Munitions Company at Verdun, which they originally constructed, and an addition to the Lymburner, Ltd., factory. At Hawkesbury, Ont., they will build a boiler house for the Riordon Pulp and Paper Company. The Montreal City Council have lately let contracts for the building of a bridge on Church Avenue to the F. J. Jago Company, and for a bridge and headgates in connection with the enlarged aqueduct to Mr. T. O. Sullivan.

The chief work of the year has been in factories, moving picture houses, schools, and churches. Some of the churches and schools are of fair size. Thus a school at Longue Pointe is estimated to cost $95,000, another for the Roman Catholic commissioners $175,000, a third $143,000, and a fourth $150,000. Plans for others are being prepared. Several new factories and additions have been erected, and it is also contemplated to build other similar structures in the east end of the city. Plans for a moving picture house to cost about $400,000 are now being drawn. The Montreal Tramways Company are constructing various sub-stations, and will link these up by a conduit system, in order to take care of additional power from a large steam plant which is to be installed. Conduit work for the city is also being carried out.

Relatively, work has been much more plentiful in the province than in Montreal. It has mainly consisted of churches and schools, with a certain amount of small bridges. In such centres as Sherbrooke the demand has been for factory buildings, due to munition work. Montreal, too, has received benefit from this source. Quebec City has shown an increase in the value of new buildings, the work there being of an all-round character, with several churches and schools running into large sums. Throughout the province there have been extensions in the way of hydro-electric development, and plans are ready for larger extensions when the money market is more favorable. Filtration plants have also been installed and altered.

Road improvements have been carried out on a

more liberal scale, thanks to the government aid, and there is promise that the programme will be continued.

It is a significant fact that the lumber trade, which is largely affected by building business, is now more brisk than at any period of the year, owing in part to orders for shell boxes, but wholesalers state that general trade is also affecting the increased volume of orders.

Good Roads Expenditure in Quebec

In the Budget speech of the Hon. Walter Mitchell, the Provincial Treasurer of Quebec, a statement was made as to the expenditure under the Good Roads Act for work done by municipalities and on government roads. The amount received from proceeds of loans under that act, and the advance made from the Consolidated Revenue Fund at the same date were:

Payments to municipalities to date	$ 9,103,148
Payments on Government roads to date ..	4,846,736
	$13,949,885
Net proceeds of loans	5,850,805
Excess of payments over proceeds of loans	$ 8,099,079
Amount allocated to municipalities to date	$ 9,573,600
Amount paid on same	9,103,148
Balance to be paid as work progresses ..	$ 470,452

The above statement shows that payments to municipalities and on government roads amount to $13,949,885, leaving a balance of $750,414 on the proceeds of the permanent loans of $15,000,000 authorized by the Legislature. It is estimated that the expenditure for the roads department in the 1917-18 fiscal year will be $300,000, an increase of $50,000.

A Proposed Intercepting Sewer for Suburbs of Montreal

A plan for an intercepting sewer for St. Lambert, Greenfield Park, Longueuil and Montreal South, has been drawn up and has been submitted for the approval of the citizens of the various municipalities. In the spring of this year St. Lambert asked the approval of the Provincial Board of Health of a plan for an outfall sewer. The Board suggested that the work be delayed with a view of the four municipalities agreeing on a scheme for an intercepting sewer. The result was the formation of a commission, known as the South Shore Municipalities Commission—to study a project for an intercepting sewer along the bank of the St. Lawrence and with its outfall below Longueuil. Each municipality was represented, with Alderman Deschene, of St. Lambert, as chairman, and Mr. T. J. Lafreniere, sanitary engineer of the Provincial Board of Health, as secretary. The Commission instructed Mr. Ste. Marie, engineer of Longueuil, and Mr. H. A. Gibeau, engineer of St. Lambert, to prepare plans and estimates under the supervision of Mr. Lafreniere.

The plan has been approved by the commission, who have also agreed on the proportion of cost to be paid by each municipality. The cost will be $216,405, divided as follows: Longueuil $33,185; Montreal South $10,000; St. Lambert $80,155; Greenfield Park $28,065. The Federal Government will contribute $65,000, in consideration of the fact that it owns a large farm in Montreal South. As the scheme proposes the use of a portion of the St. Lambert sewer, a sum of $50,600 will be allowed to that municipality, so that about $30,000 in cash will have to be paid by St. Lambert as its share of the total cost. The cost is proportioned according to the service rendered by the sewer to the municipalities, plus the area of each district.

The sewer will be built of concrete, and will commence at St. Lambert, where it will also receive the sewage of Greenfield Park. The scheme will involve the construction of trunk sewers by Greenfield Park and Montreal South and the substitution of a five-foot sewer for a three-foot sewer by Longueuil. At the commencement, the sewer will be 2 x 3 feet, this running a distance of 2,500 feet, then there will be 30-inch sewer for 2,000 feet, already built, followed by a 39-inch sewer for 7,100 feet as far as the eastern limits of Montreal South. For a distance of 9,100 feet there will be a 42-inch section, this being followed by a sewer with a capacity of 5 feet for 2,750 feet to the outfall. The sewage will be carried into the St. Lawrence a distance of 1,500 feet by steel pipes. It will be discharged at a point in the river which will allow 15 feet at low water, and the current is sufficiently strong to take the sewage away from the water intake of the municipality of Boucherville, situated below Longueuil. It is hoped by the scheme to obviate the necessity of each municipality building its own outfall, and to avoid further controversy as to the pollution of water by the various municipalities. The intercepting sewer is sufficiently large to take care of probable increases in population during the next twenty-five years. Natural conditions are favorable for the construction of the sewer, the land sloping towards the shore.

Should it be found necessary at a later date to install a purification system there is ample land near the outfall for this purpose.

The Superior Court, Montreal, has dismissed an appeal of the city of Montreal, by which the city sought to recover from the Montreal Harbor Commissioners $150,000, the cost of diverting the city sewer, rendered necessary owing to certain harbor works. The court decided that the harbor works, which had led to the necessity of diverting the sewer, were executed under federal authority. Federal works had a privilege over city works, and the Harbor Commissioners could not be held liable for the costs of the change in the city sewer.

Six hundred men are now at work on the St. Maurice dam, the contract for which is let to the St. Maurice Construction Company, Montreal. The east channel of the St. Maurice River has been pumped dry, and this section of the concrete dam built. The saw mill, crusher and mixing plants, and compressors are all electrically driven, power being supplied by a hydro-electric development at La Loutre, two miles from the work. The camps are electrically lighted.

At the meeting of the Canadian Society of Civil Engineers held on November 14th, in Montreal, a paper by Lieut. E. Laurie, of the Royal Flying Corps, on Aviation Work at the Front, was read. Lieut. Laurie described in a general way the work of the allied aviators, and also gave particulars of the engines and other portions of the equipment.

Mill Construction Shows Saving in Cost

A RECENT bulletin issued by the National Timber Manufacturers' Association contains a paper by Mr. F. E. Davidson, president of the Illinois Society of Architects, contrasting the construction of two buildings on the same site—one of standard mill construction, the other of reinforced concrete. Mr. Davidson's figures show that the concrete construction costs about 30 per cent. more than the timber construction. The paper is substantially as follows:

General Construction Costs.

I have as architect designed and superintended the construction of a great many manufacturing plants, both of fireproof construction and of the type known as standard mill and, based upon the actual construction costs, the increased cost of a strictly fireproof manufacturing building is from 25 to 35 per cent. greater than the actual first cost of an exactly similar standard mill building. In considering these costs I have included everything necessary absolutely to complete the building ready for the owner's occupancy—that is, the heating, lighting, elevators, power wiring, lighting fixtures, sprinkler equipment, window shades, window screens, etc., are all included in the cost of both types of construction. It is, of course, manifest that the actual cost of many of the items of construction will be practically identical for either type of building. I have designed standard mill factory buildings in Chicago that have cost, complete, including all of these various items, less than 7 cents a cubic foot, but I have never been able to secure the construction of a fireproof building including all of these items of cost for less than 11 cents a cubic foot, nor do I know of any accurate data showing any lower costs than those noted above.

Depreciation and Maintenance Charges.

When depreciation charges are considered I have always recommended that a depreciation charge of 3½ per cent. per year be charged against a standard mill building, and that a depreciation charge of 2½ per cent. per year be charged against an absolutely fireproof building. This, of course, shows a slight advantage in favor of fireproof construction, considering depreciation only.

As to maintenance charges: It is, of course, evident that as much outside painting and, in fact, as much interior painting and calcimining, or whitewashing, will be required for a fireproof building as for a building of standard mill construction. Practically the only thing which wears and must be replaced in a mill building is the finished flooring, and I do not know of any accurate records of maintenance cost of a standard mill building which will average more than three-fourths of 1 per cent. per year. Yet, on the other hand, I do not know of any records of the maintenance charges on fireproof buildings which will average less than one-half of 1 per cent. per year.

Insurance Rating.

As to insurance ratings: Every architect and engineer of course knows that a standard mill sprinklered building is given a much lower insurance rating than an absolutely fireproof building if unsprinklered. And even if the fireproof building is sprinklered, the difference in the actual ratings between a standard mill sprinklered factory and a standard fireproof sprinklered factory, with the ordinary occupancy, will only amount to about 10 cents per $1.000 per year on the insurable value of the building. These insurance figures can be verified by anyone, and I do not believe that anyone will dispute them.

Advantages of Standard Mill Construction.

Thus, considering first cost, depreciation, maintenance, and insurance only, the argument is all in favor of the standard mill building, and when I refer to a standard mill building I mean a building designed by a thoroughly competent industrial architect, who will enclose all stairs and elevators with brick masonry walls and have the openings to same protected with automatic fire doors, and with all windows, with the possible exception of street frontages, of sheet metal and glazed with wired glass, and with no unprotected vertical openings between any floors in the building. These are items which, more than any others, affect insurance ratings on any building.

There are in addition to the questions above noted some additional arguments in favor of the standard mill factory building. One of the principal ones which have recently been brought to the writer's attention is the fact that a skilled artisan will not work if compelled to stand on a concrete floor, if he can secure employment at equal wages in a standard mill building. Many owners of fireproof buildings have had trouble in keeping help, due to this reason only, and in some fireproof factories is has been necessary to cover the concrete floor with a layer of asphalt, or to place cork carpet or wood thereon, in order to render the factory habitable

There is yet another argument in favor of the standard mill building which in any large city should be given serious consideration, and that is the salvage value of the building itself. We all know that a standard mill building can be wrecked, and if the work is carefully done, all the structural material can be used in another structure, whereas in wrecking a concrete structure there is no salvage. In fact, I have been quoted by one of the largest contracting firms in Chicago a price for the wrecking of a monolithic concrete building which amounted to a trifle more than one-half of the original cost of the building, and our American cities are growing so rapidly that it would indeed be a courageous investor, or at least one blessed with a prophetic vision, who could predict as to what particular use a certain piece of property would be best adapted for twenty-five or thirty years in the future.

A Particular Example.

In order that the statement in regard to comparative costs made above may be brought to a definite basis, a specific case will be given in detail. The tables that follow represent the lowest proposals received by my office on a building to be erected as an addition to an existing factory. The owner at first purposed erecting the addition of reinforced concrete.

With this idea in view, plans and specifications were drawn for a concrete structure. After these plans were made the owner decided to find out what a standard mill building would cost him, with the result that another set of plans and specifications was prepared, and bids were taken on both sets of plans, which amounted to practically duplicating the contemplated concrete building in mill construction as nearly as it is

possible to have uniformity of design between the two types.

The figures that follow, applying to the mill type, are self-explanatory:

Excavation, concrete foundations, and brick masonry complete	$15,884.00
Carpenter work complete	14,374.00
Miscellaneous concrete, including fireproof stairs	3,547.00
Structural steel and miscellaneous iron	7,150.00
Sheet metal	138.00
Cut stone	735.00
Roofing	145.00
Glazing	1,365.00
Steel sash	1,436.00
Fire doors	3,360.00
Fire escapes	1,479.00
Painting	720.00
Plumbing	615.00
Electric wiring	1,100.00
Plastering	90.00
Total	$52,138.00

Exclusive of heating and sprinkler equipment.

Description.

The building is 55 feet 1½ inches by 124 feet 7½ inches in area, six storeys and basement, and contains 598,477 cubic feet. The storey heights are, in general, 13 feet 6 inches, floor to floor. The typical bays of the building are 18 feet by 17 feet 10 inches. The structure was designed for a live load of 150 pounds per square foot, in accordance with the requirements of the Chicago building code, which limits the stresses in long leaf Southern pine to 1,300 pounds per square inch in bending and 1,100 pounds per square inch in direct compression with the grain.

The floor girders are composed of two 10-inch by 18-inch timbers, bolted together, and the floor joists, or beams, are 8 inches by 16 inches, located 4 feet 6 inches, centre to centre. The girders are carried on steel post caps of the writer's own design. The floor construction is a 3-inch tongued and grooved flooring, finished with a ⅞-inch maple wearing surface.

This building is an addition to an existing factory, and it was necessary to use cantilever foundations for the entire structure. This, of course, is true for either design.

The timber specified in the contract was to be of the select structural grade, as per the new grading rules of the Southern Pine Association. The cost to the contractor in this particular building at the site was as follows: Approximately $34.50 per thousand for the 18-inch stock and $33 per thousand for the 16-inch stock.

Mill Construction Cost Per Cubic Foot

On the basis of 598,477 cubic feet, the cost of the building complete, as shown from the total cost given above, exclusive of heating, sprinkler, and architects' fees, is 8¾ cents per cubic foot. In figuring the cubical contents the space from the bottom of the footings to top of parapet wall is included.

Cost of Reinforced Concrete Design.

For the same building proposals were taken on the monolithic flat slab concrete design, and the lowest proposals presented were as follows:

Foundations, reinforced concrete, masonry and carpenter work	$55,941.00
Sheet metal	138.00
Cut stone	735.00
Roofing	145.00
Glazing	1,470.00
Steel sash	1,936.00
Fire doors	3,360.00
Fire escapes	1,479.00
Painting	790.00
Plumbing	725.00
Electric wiring	1,250.00
Plastering	90.00
Total	$68,059.00

Exclusive of heating and sprinkler equipment.

The cubic contents of reinforced concrete design on the same basis as cubic contents for the timber design equal 585,467 cubic feet. Thus the total estimated cost of building, exclusive of heating, sprinkler, and architects' fees, would be 11½ cents per cubic foot, and the difference in first cost of the two designs, exclusive of heating, sprinkler, and architects' fees, is $15,921.

Timber Design Cheaper.

The concrete design was made as inexpensive as possible and provided for the use of high carbon steel reinforcing material, and in other ways costs were cut as much as possible, in spite of which fact there was a difference of 2¾ cents per cubic foot in the cost of the two types of construction.

In this instance it will be noted that the cost of the concrete structure would have been about 30 per cent. more than the cost of the mill building, and this saving to the owner was effected in addition to the advantages he gained in the matter of quick erection, etc. The insurance rate is the same on the standard mill building as it would have been on the concrete structure.

Relief Sewer at St. Catharines, Ont.

The relief sewer in St. Catharines, Ont., which is being constructed with the ultimate object of carrying off the sewage of all that section of the city between Welland Avenue and Carleton Street and the old and new Welland canals, is now nearing completion, and it is expected that sufficient progress will have been made by the New Year to afford relief to the present trunk sewer on Carleton Street and also to make connections with the Ontario Street sewer and give relief to that section. Thus far the gangs working on Carleton Street have completed over 1,700 feet from the canal and have less than 800 feet to complete before reaching the end of the Northeast sewer which was built in 1912-13 and which will empty into the relief sewer. At Thomas Street there is a spur from the main sewer which intersects with it in a "bell-mouth." About 1,000 feet of this spur, which is 5 feet in diameter, have been completed. The main sewer from Thomas Street, along Carleton Street, is 6 feet in diameter. From the canal bank to the outlet in the canal there is a 30-foot grade and 121 feet of 24-inch cast iron pipe is used. A reduction chamber has been constructed where the sewer changes from 6 feet to 24 inches. This is a funnel-shaped chamber designed in such a way that when the 6-foot sewer is full the 24-inch outlet will be under a 6-foot head, insuring at all times a clear flow. From the Thomas Street spur east the sewer on Carleton Street is 4 feet 6 inches in diameter.

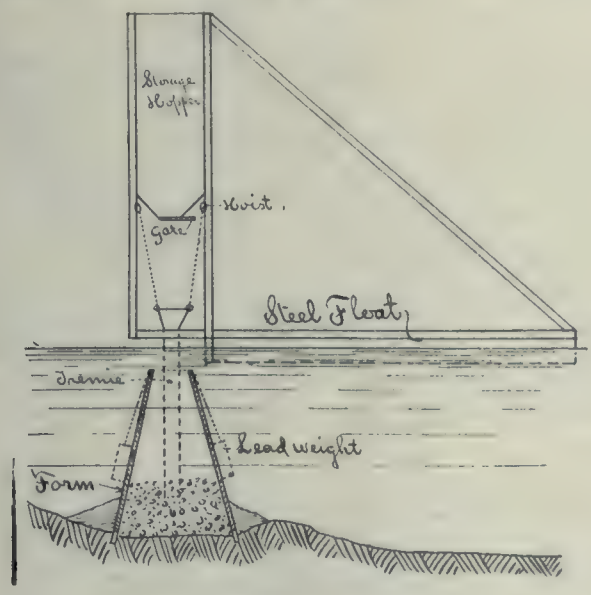
The Cleveland Brick and Clay Company, of Cleveland, Ohio, has been added to the list of licensees of the Dunn Wire-cut Lug Brick Company, of Conneaut, O., and henceforth will make wire-cut lug paving brick. The company is one of the most prominent paving brick manufacturing concerns in Northern Ohio, and it has a daily productive capacity of 60,000 blocks. J. L. Higley is president of the company and A. L. Hendershot is secretary.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Building Concrete Piers in Submerged Forms

An ingenious method of constructing concrete submerged piers reaching nearly to the surface of water from 8 to 14 feet deep was recently used in building an extension to the United States Navy boathouse at Newport, R.I., and is described in a recent issue of Contracting. Foundations for the piers were excavated by a one-half-yard dredge bucket and in them were set



Concrete piers constructed in submerged forms.

the wooden forms with 4 x 4 inch vertical corner pieces which extended below the bottoms of the forms to anchor the latter. The dredged material was backfilled around the forms to hold them in position and to seal the bottoms. Each form was ballasted with six 90-lb. lead mine weights suspended on the exterior.

The concrete was mixed in a one-half-yard concrete mixer driven by a gasoline engine and was delivered through a tin-lined chute at a slope of 5:1, to a bucket of one-third-yard capacity at the water's edge. The concrete in the chute was controlled at the lower end by a gate where the sides were elevated to prevent any overflow of the concrete.

The concrete bucket was handled by a boom rigged to a floating pile driver machine and discharged its contents into a storage hopper controlled by a bottom valve. The storage hopper was mounted in a tower cantilevered beyond a 15 x 30-ft. float moored next to the pier form.

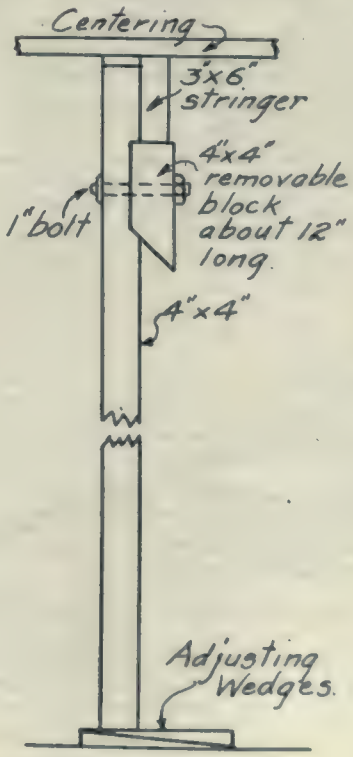
Under the storage hopper there was suspended by two three-ton differential hoists, a 15-inch tremie pipe with a small circular hopper on top. The lower end of the tremie was lowered to the bottom of the pier form and was kept 12 inches below the surface of the concrete discharged into the form.

A Shore that Remains in Place

By J. O. Smith

The ordinary type of shore—that is, a plain 4 in. x 4 in. post—used for supporting floor or beam centering in reinforced concrete buildings has to be removed to strip the work after the concrete has set. This leaves nothing to carry the floor loads except the main column, and as the concrete has not usually reached its full strength when the forms are removed, this is undesirable. In the case of the usual 4 in. x 4 in. plain timbers, generally employed, it means resetting if the supplementary support is desired. To be able to keep the shores in place and yet strip the centering, the shore shown in the accompanying illustration was developed, and is finding wide application on account of its obvious advantages.

As shown in the sketch, this shore differs from the ordinary type, in that it has a removable block bolted to the side of the main strut. A mortice, about 1 in. deep, is cut in the main member to receive the block, which is about 4 in. x 4 in. in section and about 12 in.



An improved shore.

over all the length, one end being bevelled. This facilitates removal when the bolt is loosened. The stringers that carry the centering are carried on this block, instead of the strut proper.

When the concrete is sufficiently solid to warrant the removal of the form work, the block is removed by withdrawing the bolt, and the stringers and centers can be taken down. The shore remains in posi-

tion, a board being inserted in the top to occupy the space previously taken by the centering planks. Wedges in the bottom provide for adjustment as usual.

The retaining of the shore in place helps to support the dead floor load and the live load caused by the equipment and men, during the erection of the next storey. The advantage, of course, lies in the fact that it is unnecessary to reset the shores, as is the case with the plain strut type. Time and labor are saved, besides strengthening the structure during construction.

Chuting Concrete Over Extended Areas

The application of gravity plants to structures covering considerable area where the concrete is to be deposited in comparatively thin layers has not, as a general rule, been economical.

This application of gravity plants, however, has been given considerable impetus by scarcity of labor and the higher scale of wages, and this impetus has been materially assisted by the increased economical radius given these plants by the new counterweighted chutes developed by the Insley Company.

Quick Shifts

A second factor in this work has been the successful development of the quick shift which facilitates the change of point of discharge either up or down the tower. The boom, tower, hopper, and boom bridle in these quick shift plants are mounted on a frame which operates on the outer legs of two Z bars, forming the front posts of the steel towers which are gradually replacing the old wooden towers.

These steel towers, constructed to templet and with their milled ends, lend themselves to rapid erection and for contractors whose work is located within reasonable radius they form a valuable item in permanent equipment. On the building with floors averaging, say, 6 inches in thickness, the gravity system is ordinarily applicable only to an area that can be successfully reached without the use of supports other than the tower itself or the guy lines extending out therefrom. In the case of guy lines the practical application of a successful gravity plant is largely limited by the shape

Counterbalanced chutes for distributing concrete.

of the structure. Only such structures as can be reached by a chute line supported from a single guy or suspended from and between two lines lend themselves to the economic use of a guy line plant.

Practicable Limits

It must, of course, be borne in mind that these remarks apply only to concrete deposited in thin layers requiring very frequent shifting of the point of discharge. The diagram indicates the extent to which the development of counterweighted chutes has been carried and a little experiment with paper and compass will perhaps give a clearer idea of the possibilities of these plants.

For example, the 150-foot plant will very easily cover a building 225 feet long, 100 feet wide with two wings 75 x 100 feet, and the other plants will cover a proportional area. In making an estimate as to comparative cost of chutes and cart distribution due credit should always be given for the cost of runways and scaffolds which are not needed in chute distribution. This item of cost is often more considerable than negligible.

Labor Saving

Where the concrete to be placed per hour amounts to 10 cubic yards a gravity plant will save at least five men, and this saving in men holds good for every 10-yard increase. In other words, if the rate of deposit for the concrete is 20 yards per hour a gravity plant will save ten men. It will save twenty men on a rated deposit of 40 yards per hour. Aside from saving in labor, there are features about a successful gravity plant to which but little attention has been directed so far.

Improved Mixing

Contrary to a more or less common belief, the successful operation of a gravity plant stimulates thorough mixing for the simple reason that a properly and thoroughly mixed concrete is the only one which can be placed successfully and economically with a gravity plant. Contrary also to the general belief, a sloppy concrete will not chute as readily as a concrete which is of plastic consistency. Another argument for chutes to which little attention has been given, is the elimination of damage to newly laid concrete by wheeling over it heavy loads. It is common practice to lay a floor one day and wheel over it the next, with the result that this green concrete, particularly in light structures, is very often injured. With a gravity plant there is no displacement of reinforcing metal.

Installation of System

Chutes have been very much more generally applied to concrete construction in the West than they have in the East. It is difficult to account for this other than by reference to the fact that the first chutes were used in the West. The time is coming, however, when the application of chutes to concrete work in the East will be very much extended, and in this extension the counterweighted chutes with their ease of movement will play an important part.

The first important installation of these counterweighted chutes was made by Thompson-Starrett Co., on the Field Museum building, of Chicago, Ill. Another important installation of these chutes is for the American Aluminum Company, on their Knoxville power plant.

Portable Steel Buildings for Construction Camps

On many large construction jobs portable buildings composed of steel units are now being used for offices, bunk houses, shops and other purposes. These portable steel buildings are composed of units—side wall panels, mullion supports between the panels, pressed steel trusses and steel roofing plates—and are generally put together without the use of bolts or rivets.

These portable steel structures are also being used for factories, storehouses, fabricating mills, in fact they are being built up under every condition where a one-storey building can be used.

Brick Institute to Hear Live Topics

The forthcoming meeting of the Paving Brick Institute, to be held at the Statler Hotel, Cleveland, Ohio, on December 5 and 6, will discuss a programme replete with valuable information to the operating departments of the industry. The following papers comprise the programme:

"The Use of Powdered Coal," by Mr. A. A. Holbeck, of the Bennet Company, Canton, Ohio.

"Producer Gas in Burning Brick," by Mr. John.T. Underwood, Inventor of the Underwood Producer Gas Burning System.

"Equipment Efficiency," by Mr. F. R. Kanengeiser, of the Bessemer Limestone Company, Youngstown, O.

A paper by Mr. George D. Orr, of the Purington Paving Brick Company, Galesburg, Ill., on the subject of "Labor."

"The Development and Application of a Bonus System," by Mr. S. M. Duty, of the Medal Paving Brick Company, Cleveland, Ohio.

National Good Roads Show

Reservations of exhibition space at the Eighth National Good Roads Show, to be held at Boston, Mass., February 5 to 9, 1917, under the auspices of the American Road Builders' Association, predicate the most important exhibition in the history of the organization from the standpoint of educational value. The show will be held in Mechanics Building on Huntington Avenue, which is admirably located and equipped for the purpose. The building contains a very large amount of floor space, ample for practically any number of exhibits and adaptable to exhibits of any size. The Good Roads Show will be held in conjunction with the Fourteenth Annual Convention of the American Road Builders' Association, the programme for which is now in course of preparation. Many of the foremost specialists in highway work and bridge building have already signified their intention of being present and participating in the proceedings. Coming as it does, just prior to the opening of the season's activities, the convention and show will afford road and street officials, engineers and contractors an excellent opportunity to familiarize themselves with the latest developments in road building machinery and materials and the most modern practice in highway work as followed by the leading authorities in this field.

Westinghouse Equipment in B. C.

The Slocan Star mines at Sandon, B. C., have installed one 250 kw., 3-phase, 60 cycle, 220 volt, 360 r.p.m. Westinghouse generator, direct connected to Pelton-Doble tangential water wheel with Pelton governor. Standard switchboard panel, belted exciter, 75 h.p. motor and transformers have also been supplied by the Canadian Westinghouse Company, Limited, Vancouver.

B. C. Cedar Shingles Described in Bulletin

Shingles — The British Columbia Government, through the chief forester, has issued a bulletin descriptive of British Columbia red cedar shingles. The bulletin states that British Columbia red cedar has certain qualifications which preeminently fit it for the manufacture of shingles, and instances as the most important of these qualifications its marvellous resistance to decay. It is claimed that instances are known of fallen trees 800 to 1,000 years old, the wood of which is still perfectly sound. The booklet is artistically illustrated and contains a quantity of useful information for anyone interested in this subject. Enquiries in Eastern Canada should be directed to the B. C. Lumber Commissioner, Excelsior Life Building, Toronto.

When "U" is "V"

Why do modern architects assvme that U is V, and carve in stone that palpable and bold absvrdity? Now that we possess the U, with soft and gracefvl cvrve, of vnexcelled docility and willingness to serve, why do they carve VNITED STATES and PVBLIC SCHOOL and svch, and make the English langvage look as fvnny as the Dvtch, with RESTAVRANT and PVLLMAN CAR and VNIVERSITY and other marks of edvcational perversity? That V impresses some of vs as cheap and gavdy blvff, which parvenves may pvll in place of more svbstantial stvff, bvt people who are fashioned ovt of vnpretentiovs dvst view all svch affectation with an vnassvmed disgvst. Svch exhibitions always make vs glvm and blve. Now, honest Injvn, don't they have the same effect on yov? —Printer's Ink.

The first meeting, for the present season, of the Victoria branch of the C. S. C. E. was held on Wednesday evening, November 8.

Mainly Constructional

East and West—From Coast to Coast

The Walkerville Construction Company has been incorporated with a capital of $40,000, headquarters at Walkerville, Ont.

The Fort William Temple Building Company, Limited, has been incorporated with a capital of $40,000, head office, Fort William, Ont.

Reid Products Company, Limited, has been incorporated with a capital of $40,000, headquarters at Toronto. The company will deal in incinerators and building and metallic specialties and carry on the business of general contractors.

Rumors have been circulated that when work on the Welland Ship Canal is shut down for the winter season, it will not be resumed again until after the war. It is stated that the original estimate of cost, $50,000,000, will likely be exceeded under existing conditions.

The York Township Council has adopted the report of Mr. Frank Barber, C. E., township engineer, on the proposed waterworks system for a portion of the township west of Yonge Street and lying against the northern and western limits of Toronto. The scheme will involve the expenditure of about one million dollars.

The Gordon Granite Company, who operate a granite quarry near Gananoque, Ont., have been awarded a contract by the city of Toronto to supply them with all the granite blocks that city requires for the year 1917, which will be in the neighborhood of one million. The blocks are 7 to 10 inches long, 4 to 4½ inches thick, and 4½ to 5 inches deep.

Building operations are being commenced on a new steel warehouse in the Toronto harbor industrial district for

Messrs. Baines and Peckover, steel merchants, to cost $20,000. Lease has been authorized to the firm for the property for the site, which is at the foot of Cherry Street, immediately southeast of the new Cherry Street bridge. When fully developed the total expenditure will be in the neighborhood of $225,000.

In a recent letter to the town planning commission of St. John, N.B., Mr. Thomas Adams, the government town-planning expert, expressed the opinion that many changes were required in the laws governing street making in St. John. Amongst other recommendations he suggested that 50 feet should be made the average width of the streets and that sub-division owners should be required to put proposed streets in shape before being taken over by the city.

A letter has again been received by the Hamilton, Ont., city council from Chief Engineer Jas. Bain, of the Beach pumping station, who draws attention to the necessity for immediate action in regard to increasing the pumping equipment and disclaims responsibility in the event of damage to property or loss of life, occasioned by a shortage of water, due to power failure or other emergencies. He states that a duplicate system with a capacity of at least 25,000,000 gallons is required to take care of immediate needs whether the reservoir is filled or not.

An interesting judgment has just been rendered in the Superior Court by Mr. Justice Lafontaine. Recently a contract was signed between Andre Bray, contractor, and the municipality of Laval des Rapids, for the construction of a system of sewers, and one clause in the contract stipulated that for each day a certain time limit, set for the completion of the work, was exceeded, the contractor should pay a penalty of $30; of which amount $10 should go to the consulting engineers, Messrs. Ouimet, Lesage and Desroches. The time limit was actually exceeded by 165 days, and action was brought against the contractor, by the engineers, to recover the penalty. The defendant claimed that he had no agreement with these engineers, and further, that delay was caused by the municipal authorities themselves. This coincided with the viewpoint of Mr. Justice Lafontaine, and the action was dismissed, the town being condemned to pay the costs.

Work on the Great Northern depot at False Creek, Vancouver, B.C., is progressing favorably and it is hoped that it will be completed by the first of the year. Since the start of operations in April between 150 and 200 men have been employed on the work and 80,000 yards of material have been used every month. In all there will be nine miles of track at the new depot, consisting of seven passenger, six freight, four team, one long industrial and eleven coach tracks. Other buildings to be erected at the station will be the engine house and fifteen brick stalls, brick storehouse, commissariat rooms, and car repairers' offices. Another venture which is at present occupying the attention of the railway company, is the construction of a large 42-inch sewer pipe, made of reinforced concrete. This pipe is built for the purpose of carrying surface drainage across to South Heads. At this point, the C. N. R. will connect up and take it to their main sewer, which is also now under construction. A line change which is being made at Sapperton and Pitt entails the erection of a steel bridge to carry the main road from Westminster to Port Moody.

Personals

Mr. R. W. Macintyre, secretary of the Victoria branch, C.S.C.E., has been elected a member of the Am. Soc. C. E.

Capt. C. E. Kilmer, who went overseas with the 19th Battalion, has been awarded the Distinguished Service Order. Capt. Kilmer was wounded in August last and his right leg was amputated below the knee. He is a Toronto man and had been employed in engineering work in New Brunswick.

Lieut. R. Lawrence Junkin, of the 5th Field Company, Canadian Engineers, has been awarded the Military Cross, having distinguished himself on the field. Lieut. Junkin is 26 years old, and has been in the trenches fourteen months. He was a graduate of the School of Practical Science, Toronto, and was gazetted to an Ottawa Company of the Engineers.

City Engineer R. R. Knight, of Fort William, Ont., has accepted a commission with the Canadian Engineers and will go overseas with the expeditionary force, having obtained leave of absence from the city council. Mr. Knight, who now takes the rank of lieutenant, has been in the service of Fort William for more than three years, going there from the Toronto engineering department in February, 1913. The completion of the Stanley avenue sewer was carried out by him, as was also the extensive paving scheme of 1914, when Fort William streets were improved by the construction of many miles of asphalt, macadam, rocmac and gravel. Lieut. Knight had his early engineering experience in England.

A letter from a Manchester hospital written by a sergeant of the 33rd Battalion and dated October 29, gives the most direct information that has yet been received regarding Major W. N. Ashplant, London's former city engineer. It appears that Major Ashplant was wounded on the night of September 22 in an attack on the German trenches in front of Courcelette, and a corporal, who was himself wounded the same night, had seen him and offered to help him to the rear. The Major, however, replied that his arm and leg were shattered and requested him to send stretcher bearers. The corporal informed two different parties of stretcher bearers where he had left the wounded man, but they failed to find him. It is possible, the letter states, that Major Ashplant has been picked up by a German patrol, or, crawling off, wandered into German territory. Otherwise, his body has probably been buried by a shell. There is still hope, however, that he is alive and that news of him will be received from Germany.

Obituary

Private Albert Bates, a builder and contractor, who for some years carried on a successful business at Swift Current, Sask., has been killed in action at the front. When the war broke out he enlisted with the mounted police, later joining a battalion at Saskatoon.

Mr. Alexander T. Stewart, of Toronto, a well-known and highly respected citizen of the west end for many years, died recently at the General Hospital. Of recent years Mr. Stewart had been engaged in the building contracting business, in which he operated on an extensive scale. He was an ex-alderman, having represented Ward Five in the city council in 1905.

Flight Lieut. J. A. N. Ormsby, who has been missing since August 8, is now officially reported killed. Lieut. Ormsby was 22 years of age. He was in his third year at the School of Practical Science, Toronto, when he joined the Eaton Machine Gun Battery. He went to England with that unit, and there transferred to the Royal Flying Corps and received his training in aviation.

Lieut. E. F. M. Dann, a British Columbia civil engineer, who for four years had been employed in that province in connection with the irrigation work of the Dominion Government, died of wounds on November 3, somewhere in France. Lieut. Dann was a graduate of the School of Practical Science, Toronto. He enlisted with the 72nd Battalion, Seaforth Highlands, Vancouver, and had been in France since August, 1915.

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Revision of Plan of Toronto End of Toronto-Hamilton Highway Necessary

THE present season witnesses the practical completion of the Toronto-Hamilton Highway, the concrete roadway connecting Toronto and Hamilton, a distance of some forty miles. At two or three points along the line where considerable streams of water have to be crossed, there still remain to be constructed short sections of roadway which must be held up until these bridges have been strengthened and possibly rebuilt. The only considerable break in the road, however, is that between the western limit of York county and Sunnyside, Toronto, which includes Swansea, New Toronto, and Mimico.

Many circumstances have combined to delay the building of the roadway over this section. It was early appreciated by the Commission that the original 18-foot road allowance would prove totally inadequate for the amount of traffic that must pass over this section of the route. For this reason, alternative propositions were submitted, these being the construction of a wider roadway along the route as originally planned, or a diversion of the road so as to pass outside and north of these villages, meeting Queen Street extended further west. The objection to the second alternative was the crossing over the Grand Trunk Railway system, which would have necessitated either an overhead bridge or a subway, and this route has reluctantly been abandoned. At the present time there is apparently no alternative but to construct the roadway along the main thoroughfare of the above-mentioned villages, known as the Lake Shore Road.

* * *

One of the circumstances realized by the Commission since the beginning of this work, which was possibly not appreciated by them at the time of its inception, and probably is not understood by the general public even to-day, is that figures of traffic conditions on this road under the old conditions are no criterion whatever as to the future requirements of the concrete roadway. Experience already gained on the Hamilton end of the highway shows that the traffic is very much greater than was anticipated. For example, in August, 1914, a traffic census on this highway route five miles from Hamilton showed a maximum daily total of 298 vehicles. In October, 1916, at the same point, this total had reached 1,521 vehicles. If this is true of Hamilton, it will, in all probability, be the case to an even greater extent with a city the size of Toronto, so that, with the completion of this road, we may expect to find traffic double, treble or quadruple immediately, with increases continuing at a very high ratio from year to year. Judging from the Hamilton figures given above, we may expect a daily traffic, near Toronto, anywhere up to 9,000 vehicles. The big problem before the Commission's engineers at the present time, therefore, is how to make provision for this traffic when they are only authorized to construct an 18-foot roadway.

* * *

The real position, then, at the moment, seems to be this—that the Commission's engineers feel that the roadway as originally planned along this section of the route will almost immediately prove totally inadequate for the requirements, and they are contending that it is evidently not the part of wisdom to build such a roadway as must be widened and improved in the course of a year or two, with the consequent extra expense and added inconvenience which the elaboration of any plan carried out on too small an original scale always entails. We understand it to be the engineers' recommendations that this section of the roadway allowance should now be increased to a minimum of 86 feet, leaving room for street car tracks in the centre of the roadway and providing for a travelled roadway at least 30 feet in width of which 24 feet is concrete.

This larger programme would, of course, add still further, very considerably, to the original estimated cost, but we cannot see that there is any other common-sense course to pursue. There is no doubt of the value of this roadway or that the amount of traffic will justify its construction. Now that so much money has been spent and a good road laid between the cities, it would appear to be the only wise course to follow to construct a proper entrance into the city of Toronto. As a matter of argument it is quite logical, respecting any road between two main points the

The annual report of the Bank of Montreal, just out, emphasizes, in the marked increase in deposits, the prosperity of the general saving population of Canada. Deposits not bearing interest have increased from $75,745,730 to $88,767,018, while savings deposits have gained over 30 per cent.—from $160,277,084 to $210,439,031.

size of Toronto and Hamilton, that the capacity nearer the cities must needs be greater than midway between the two cities; unless we are to take it for granted that all traffic initiating in one city is carried right through to the other—evidently a wrong supposition. As a matter of fact, traffic on such a roadway will take on something of the nature of interurban electric railway traffic, the characteristics of which are well known, that is, as the larger centres are approached, the number of passengers carried is greater, and vice versa. Heavy though the financial load may seem, therefore, at the present time, we cannot see the wisdom of the argument that the original plan must be followed, and an 18-foot roadway only must be built along the remaining section. Better build the road right in the first place and have done with it, or leave it as it stands until such time as we can afford to build it right.

There is undoubtedly a considerable prejudice against the way this roadway has been handled, but there is one great satisfaction in knowing that the fault does not lie with the engineering profession. Also, it is worth remembering that the roadway was started partly as a relief scheme to give work to the unemployed. For that reason the Commission was saddled with a very large percentage of unsuitable labor, inefficiently applied at best, a condition which has given place in recent months to more suitable labor, possibly, but to labor which costs approximately twice as much. However, we know of no reason for thinking that the people of Ontario are not getting value for money expended, and this is the main consideration. The road has cost no more than it would have cost had proper estimates been made before the work was commenced. The error was a political, not an engineering one. In any discussion concerning the roadway, this point at least must be made clear and amply maintained.

Large Engineering Plant on the Pacific Coast

A few months previous to the outbreak of the war plans had been about completed by the Amalgamated Engineering & Drydock Company for the construction on Burrard Inlet of the largest drydock, shipbuilding and engineering plant on the Pacific Coast. At the head of the big undertaking was J. C. V. Spratt, of the Victoria Machinery Depot, Victoria, who had succeeded in interesting the necessary capital in the Eastern States and Eastern Canada. The project had the backing of the Dominion Government to the extent of a guarantee of four per cent. for a period of thirty-five years on the cost of the drydock section, which was to be built to accommodate the largest ships at an estimated outlay of $5,500,000. The site of the plant on the North Vancouver waterfront had been secured and preparations were being made for a start on construction when the declaration of war brought matters to a halt.

The insistent demand from neutral countries for ships to replace the vessels being destroyed by submarines has unexpectedly revived interest in the big project, and there now seems every prospect of work being resumed with feverish activity. Millions of Eastern capital is now looking for profitable forms of investment, and those in control have been quick to recognize the great opportunities presented in the prompt creation of a great shipbuilding plant on the Pacific Coast of Canada. It is understood that the contract for construction has been let to a United States firm with instructions to rush it to completion so as to permit the new company to make an early start on several steel ships offered by representatives of Norwegian interests now in Vancouver.

Steel Houses for the War Zone

A scheme is at present under discussion in connection with the building of large numbers of portable houses for the war zone. Certain of the allied governments are negotiating with manufacturers for the designing and building of these shelters, which, though intended to be temporary in character, must be durable and complete enough to accommodate family life for an indefinite period. Originally enquiries were put out for vast quantities of lumber from which to construct these houses, but it was found this material would make the cost excessive, and the plan was dropped. Now it is proposed to employ steel construction, which, if a uniform design is adopted, can be produced in great numbers at a minimum cost. The proposed houses are to be 12 by 24 feet in ground dimensions and 9 feet high. They are to contain two rooms. A plan now designed calls for the use of a framework of light channels and a covering of 26 to 28 gauge galvanized sheets, or some other uninflammable material. Each of these structures will contain about a ton of steel. If this type is adopted the aggregate steel requirements wll be enormous, in view of the great numbers required. France alone has been considering the ordering of 100,000 houses, and the other entente powers are expected to order in equal proportion. The houses are to be used both to shelter the soldiers at the front and to provide comfortable accommodations for the general inhabitants in devastated territory until the final reconstruction work in these districts can be safely inaugurated.

Exports of firearms and explosives from the United States for the four months, July, August, September and October, seem to add strength to the statement now frequently heard that the Allies, i.e., at least England and France, are now nearing the point where they are independent of outside manufacturing plants. Here are the figures:

July	$58,565,000
August	52,236,025
September	49,878,196
October	43,039,085

The annual convention of the American Concrete Pipe Association will be held in Chicago, February 12, 13, and 14, 1917, these dates falling during the second week of the Cement Show.

The St. Johns-Iberville Bridge, Quebec

A 1500 ft. Structure with Two Bascule Spans and Eighteen Girder Spans—Built with Floors of Hollow Concrete Beams

AT a cost of $175,000 a steel and concrete bridge has been erected over the Richelieu River, P. Q., connecting the towns of St. Johns and Iberville. The Provincial Government contributed $92,000, the Dominion Government $52,000, and the balance was contributed by St. Johns and Iberville, in the proportion of two-thirds by the former and one-third by Iberville. The cost of maintenance is borne by the towns in the same proportions. The structure replaces a wooden toll bridge, the present bridge being free. On the St. Johns side the Chambly Canal runs alongside the river, being separated by cribwork, and in order not to interfere with the barges it was found necessary to erect a bascule bridge; on the other side of the river there exists a wharf which necessitated a smaller bascule bridge being constructed.

The bridge consists of two abutments and nineteen piers, with a steel superstructure, the entire length being 1,525 feet from abutment to abutment. The piers and abutments are of concrete, while the spans consist of one 85-foot bascule over the Chambly Canal, one 45-foot bascule over the Richelieu River, 17 plate girders 80 ft. centre to centre on the piers, and one 35-foot span. The piers are 5 feet at the top, 9 feet at the bottom, and 36 feet in length; they rest on sixty wooden piles driven to refusal. After the piles were driven, cofferdams were built, and concrete about 6 feet thick laid in water; after being allowed to harden for ten days, the water was pumped out, forms built inside the cofferdam and additional concrete poured.

Provision is made for both vehicular and passenger traffic, the two sidewalks being 4 feet wide and the roadway 17 feet wide. The floor system is made of 7-inch Siegwart concrete beams, 10 ft. long, manufactured by the Canadian Siegwart Beam Company, Limited, Montreal, laid on 18-inch I-beams at 55 pounds. On the top of the Siegwart beams Clinton electrically welded fabric, manufactured by the Pedlar People, Limited, was laid, in order to spread the concentrated load over each unit of four beams. The road was finished with a 6-inch concrete covering at the centre and 4½ inches at the sides. Four and three-quarter-inch Siegwart beams were used for the sides. The bridge is designed to bear 100 lbs. per square foot or a 20-ton road roller, whichever produced the greatest stress.

Fig. 1—Deck of Gouin bridge, showing arrangement of hollow concrete beams. This is covered with electrically welded fabric and finished with concrete.

Both the bascules, built from plans by the Strauss Bascule Bridge Company, Chicago, are of the same type, except that plate girders are employed on the Iberville side and lattice girders for the one over the Chambly Canal. A platform of reinforced concrete is erected on the abutment at the Chambly end to take care of the electrical machinery used in operating the bascule over that canal. The other bascule is operated by hand. As the pier in the canal interfered with the horse haulage of the barges a wooden trestle has been erected to allow of the passage of the horses from one side of the bridge to the other.

The superstructure was fabricated by the Dominion Bridge Company, and erected by the contractors, who adopted the method of floating the spans into position. A siding was constructed to convey the steel

Fig. 2—Gouin bridge between St. Johns and Iberville, P.Q., during construction. View of the deck end showing the Siegwart concrete beams in place.

to the wharf near the site of the bridge. The spans were erected at this point, a locomotive crane being employed to lift the heavy pieces. The erection was done on a scaffold, and the span was transferred to a scow, the latter being pulled to the site and floated in between two piers. The scaffold, with the span; was about six inches higher than the top of the pier, and when the span had been placed in position, a valve in the scow was opened allowing the scow to slowly settle. The ends of the span thus rested on the bridge seat and the scow being free was pulled to the wharf and loaded with another span. All the plate girders, with the exception of the bascules, were erected in three weeks.

The Two Bascule Bridges

The Gouin Bridge embodies, as mentioned above, two bascule spans, which, although they are of the same general type, differ in many essentials. On the St. Johns side and crossing the Chambly Canal, there is a single leaf bascule span giving a clear channel for navigation of about 70 feet, having pony trusses and

Fig. 3—Gouin bridge between St. Johns and Iberville P.Q., during construction showing plate girder spans and hoisting of floor beams. Total length of bridge 1525 ft. between abutments.

operated by electric power; while on the Iberville side, near the shore of the Richelieu River, there is a single leaf bascule span, giving only a 30 ft. clear channel, having deck plate girders in harmony with the stationary parts of the bridge and operated by hand. Both bridges are of the Strauss Trunnion bascule type with

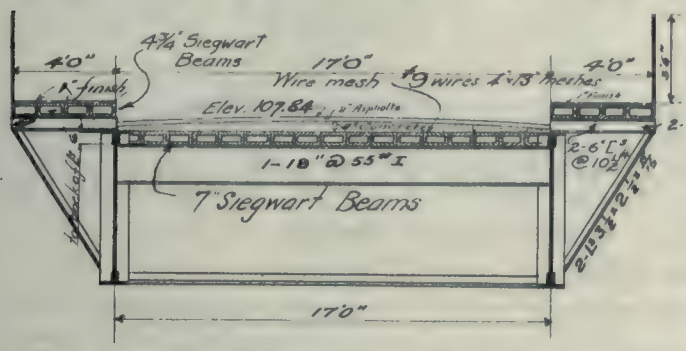


Fig. 4—Cross-section of bridge span, showing the floor arrangement.

overhead counterweights, and were designed by the Strauss Bascule Bridge Company, of Chicago.

In the Strauss system, as exemplified in these two bridges, the span is supported on, and rotates around, stationary shafts or trunnions which rest in ordinary shaft bearings of large dimensions. The main truss, or girder, is extended back of this trunnion into a so-called tail end, and at the extreme end of this is located another trunnion, the counterweight trunnion, which supports the counterweight necessary to balance the bridge. This counterweight is so determined and adjusted as to completely balance the structure at any angle of opening whatever, and the operating machinery, therefore, has merely to overcome the frictional resistance, the wind resistance, if any, and the inertia of the structure. The counterweight consists of a reinforced concrete block which extends from one side of the bridge to the other, overhead and across the

Fig. 5—Strauss trunnion bascule span on Gouin bridge over Chambly canal. Single-leaf pony truss type, 85 ft. long; electrically operated.

roadway, and this block is supported on steel columns, or legs, which, at their lower end, are pin connected to the tail ends of the main trusses or girders by means of the counterweight trunnions referred to above. In order to maintain the counterweight in a vertical position, during the movement of the bridge, it is guided by a pair of "links," made up of structural steel and braced one against the other, these links being pin-connected at one end to the counterweight and at the other end to the counterweight tower, which is in the nature of a structural steel portal frame spanning the roadway at the trunnion pier. A line drawn between the two pins connecting each link to the tower and the counterweight respectively, is parallel, and equal in length, to a line drawn from the main trunnion to the counterweight trunnion and the two trunnions and the two piers, therefore, form the corners of a parallelogram which will change its shape but which will remain a parallelogram during the operation of the bridge.

The difference in dimensions and character between the Chambly Canal bascule and the Richelieu River bascule is, of course, not accidental, but is due to the difference in the traffic on the two waterways.

The Gouin Bridge is located near the end of navigation on the river and the river span will therefore be used only very rarely. For this reason a 30-foot channel was deemed sufficient, and this made it possible to carry through the deck girder design which

Fig. 6—Strauss bascule span on Gouin bridge over Richelieu River. Single leaf plate girder type, 45 ft. long; hand-operated.

was used for the stationary parts of the bridge. It was also deemed sufficient to arrange this span for hand operation, and the operating machinery therefore involves nothing more than a pair of detachable hand cranks, operated from the bridge floor, and which, by means of a sprocket wheel and chain and a simple train of spur gears, revolve two operating pinions which engage cast steel quadrants or rack segments, bolted to the tail ends of the girders. There is also a simple hand brake provided, by means of which the operator is enabled to hold the bridge in any position if so desired.

The Chambly Canal is subject to a very considerable traffic, and the government therefore required a 70-foot clear channel in the bascule over the canal, which, in connection with the fact that the elevation of the roadway at this end of the bridge is considerably lower than at the other, made it necessary to resort to a semi-through or pony truss span and to provide for power operation; in this case, electric. The bridge is equipped with two 7½ h.p. electric motors, operated on a 550 volt, 3 phase, 60 cycle alternating current and controlled by means of a drum controller in the operator's house. The motors are equipped with

solenoid brakes, which set automatically as soon as the current is cut off from the motors by means of the controller, and in addition there are two shoe brakes, one on each side of the bridge and operated by means of a lever in the house. The motors, through a series of spur gears, operate two operating pinions which engage cast steel racks attached to the tail ends of the trusses, and in this respect the machinery layouts for the two bascule spans differ only in size.

The bridge is lighted by nitrogen filled lamps, on ornamental standards, placed every eighty feet. At each entrance are two five-cluster lights. The water in the river was 16 feet deep at the time of construction. The work was started in December, 1914, and completed within a year. The bridge was designed by Mr. S. A. Baulne, consulting engineer, Montreal, and the contract carried out by Laurin & Leitch, Montreal.

The Ability of the Engineer in Canada

Sir Wilfrid Laurier's Address to the Ottawa Branch C.S.C.E.—A Reputation for Integrity and Efficiency

THE second luncheon for the fall season under the auspices of the Ottawa branch of the Canadian Society of Civil Engineers was held at the Chateau Laurier on Thursday, November 23, Mr. John Murphy, chairman of the branch, presiding. Sir Wilfrid Laurier was the guest of the branch, and addressed them briefly on "The Engineer in Canada." Sir Wilfrid spoke as follows:

Mr. Chairman and Gentlemen,—I thank you that it is to-day my privilege to sit with you at this hospitable board, and I hasten to offer to you, sir, and to the members of the Canadian Society of Civil Engineers a sincere expression of my gratitude for the honor of the invitation with which you have favored me. I appreciate it all the more that I am here with none of the trammels and trappings of office. I come to you, as you are yourselves, a humble citizen of Canada, and the only bond of union which I know at this time between you and me is that, whilst you have the pride of the profession which you embraced in your younger days, I, for my part, have the pride of the achievements of the engineers of Canada.

Sir, you have just told me that I am 75 years young, which, I am bound to say, is a flattery which I cannot accept. I am 75 years old. That is the fact; I cannot help it, and, therefore, why should I disguise it? I am 75 years old, but I have this to say, that I ought to be thankful to Providence that my eye is still clear, and if you will permit me to refer to a subject to which I shall not further allude, I think I have yet a few kicks in my body. In the course of a long career, which has been devoted to the public service, as I have understood it, it was my proud fortune to come in contact—and sometimes in very close contact—with some of the engineers of the past—all able men, all men of the greatest eminence, all men held in the highest respect not only within the sphere of their own immediate calling, but within the broader circle of Canadian citizenship. I refer to the dead alone; I refer to such men as Frank Shanly, Thomas C. Keefer, John Page, and Toussaint Trudeau, and if I were privileged to speak of the living, I could not help mentioning the name of my very old and dear friend, Sir Collingwood Schreiber, whom I am so glad to see at this board to-day. All these men were connected in their day with all the great works on the St. Lawrence and the Great Lakes—bridges, canals, wharves, and other works which uplifted Canada from a position not very far removed from that of primitive savagery to the proud position which it now occupies in the eyes of the civilized world. The labors of these men showed that, even in those early days in our country, Canadian engineers were the peers of the engineers in any part of the world. They do not claim to be the superiors, but they do claim to be the equals, and it is with much reason that they make that claim. They do not fear rivalry from any quarter from which it may come. In our own day we have had evidence that when engineers are brought in from other lands the work is not done better, but that, on the contrary, it is not done as well as if it had been undertaken by our own engineers.

May I recall a fact with which I am, unfortunately, but too well acquainted? When the Quebec Bridge Company undertook to construct the bridge across the St. Lawrence it was seen to be a work of such magnitude that many believed that the resources of engineering science in our own country would not be adequate, and the board of management of the company entrusted the building of the bridge to an American firm. The plans of the bridge were designed by an American engineer, an engineer of great eminence undoubtedly, an engineer of great renown, who had had a large career in bridge engineering, and who was supposed to be the highest authority in that branch of engineering science. His plans were accepted—I will show you why bye and bye—and you know the result. The story is always present in our minds; at all events, it is always present to mine. Before the first span of the bridge had been completed it dropped into the St. Lawrence, under its own weight, conclusively showing that the plans were defective, a fact which was not disputed by even the engineer who was the author of those plans. For my part, as a Canadian, I may say, in all sincerity, and I do not seek to disguise it, the only consolation I have with regard to this accident is that the plan was not the work of a Canadian, but of an American engineer.

But, sir, the poet has said that "to err is human; to forgive divine." We forgave—that was the only thing to do—but we determined to try our luck anew and to try it under other auspices and circumstances. We determined to go on with the work at that time, but to transfer the enterprise from the hands of the company to the hands of the government of that day; that was in 1908. We determined this time to entrust the work to Canadian engineers and Canadian builders. Unfortunately, as you know, at the last moment an accident occurred; but the accident showed, and showed conclusively—and this is a fact of which we all as Canadians must be proud—that it was not due to any fault in the design of the bridge, because the bridge structure remained as solid as the rocks on the shore under the terrible strain which was put upon it by the sudden drop of the central span. We have the most conclusive

evidence, and it is a fact which was not only evident to those who were present on that fatal day, but which has been proved by actual examination, that no fault is to be attributed to the engineers. The accident was due to a flaw in the metal. From all this I think there is to-day a lesson to be drawn, and that lesson is that it is folly to go abroad to seek what we can find at home. We can make a mistake once—that is pardonable—but it is unpardonable to make the same mistake a second time.

I do not belong to your profession, but I honor it not only because it is the profession of engineering, but because the engineers are fellow-countrymen of my own and we are Canadians all. Canadian engineers do not pretend to, do not claim, any superiority over the engineers of any other country; neither will they admit inferiority to the engineers of any other country. They claim that they are equal to the highest development of engineering science to this day; or, if they are too modest to claim it, I claim it for them. That is my view, and I express it as I feel it, not only in your presence, but I would be glad to do so wherever my voice can be heard in any part of Canada. I make this claim for the engineers of Canada, that they are the equals of American, of British, of French, or German engineers.

There is something more which I claim for the engineers of Canada. I claim for the engineers of Canada not only ability, but character, and by character I understand honesty and honor. I was for fifteen years the Prime Minister of this country, and in connection with public works under the charge of the government over which I presided I had a great deal to do with Canadian engineers, and it is my proud testimony to say that I always found that the Canadian engineer could be depended upon for honor and honesty. Honor and honesty were characteristics of those engineers whose names I selected from a great number and whose names I have just given to you. Their honor and honesty were such that, when I had the responsibility of office, if I saw the signature of Mr. Collingwood Schreiber, or any other Canadian engineer, upon a report or plan, I knew that it meant that there was the truth, and that the work might be proceeded with. Honor and honesty are required in every branch, in every part, of our life, but honor and honesty are, perhaps, more required in the engineering profession than in any other calling. It is characteristic of the work of your profession that the work of the engineer cannot be intelligently criticized or approved by the layman who commands the work. The plans, the calculations of the engineer, when they are brought before the unpractised eye of the layman who has to do with the work—I speak, at all events, for myself as a humble layman—present nothing to him but what he regards as a jumble of lines and figures. He can look, but he cannot pronounce upon them; he cannot undertake to say that the lines are too long or too short, that the angles are too sharp or too obtuse, or that the calculations are right or wrong. It is not so in many other lines or in many other arts and sciences. Take the case of architecture. If I employ an architect to put up a building for me, he brings me his plans; I look them over, and I can see whether or not they please me. I can sit down and discuss and argue with him. I can say to him: "I do not like this curve," and he can answer me and say: "You are wrong; you do not know the accepted canons in that respect; if I were to do the work as you suggest I would make a bad job of it." Eevn if I could not convince him, I could, at all events, give him my views. But if I employ an engineer to prepare for me a plan of a conduit or a canal and he brings to me his designs, his lines, and profiles, I will be a very presumptuous man if I undertake to say that his calculations and lines are wrong. We have to depend upon the ability and character of the engineer to do this work for us, and whenever I had to depend upon a plan put before me by a Canadian engineer, I proceeded on that plan which was put before me, and which represented the sum total of engineering science, backed by a firm and rugged honesty. I asked no more and never was deceived. Ability and character are, not only to my knowledge but in my experience, the double attributes of Canadian engineering. Canadian engineers have always lived up to that double standard, according to my observation and experience. They have always held these characteristics up as the standards by which they desired to be judged, not only for themselves, but also, may I say, for the fair name and fame of Canada, our country whose name and fame must always remain dear to all the sons of Canada.

Now, Mr. Chairman, you have been kind enough in your introductory remarks to speak of my age. I shall not refer to that; but you have been kind enough to mention the name of my wife, and for that I cannot be sufficiently grateful to you. You all know—I suppose most of you do—the blessing of a good wife. I have had that blessing during a very long life. Now, I have to cut my remarks short because, pleasant as this occasion has been and thankful as I am for the opportunity of being with you, I am going to something even better than a banquet with the Engineers—I am going to a wedding.

A vote of thanks was moved by Mr. A. St. Laurent.

Demand for Oil Storage Tanks

The Toronto Iron Works state that they find the demand for oil fuel storage tanks is very heavy. Among the orders received during the past thirty days are the following: The Fess Oil Burners of Canada, Ltd., five 8,000 gallon storage tanks for installation in the Robert Simpson mail order building on Mutual Street; the Robert Simpson Apartment House on Bleecker Street; the Flint Varnish Company, Perth Avenue; Messrs. Clarke & Clarke, Christie Street; and in Earl Grey School; the town of Chatham, N.B., one each standard 12,000 gallon and 5,000 gallon storage tanks; the Metal Drawing Company, St. Catharines, two 6,000 gallon tanks; the Canadian Bronze Company, Montreal, one 10,000 gallon tank; the Northwestern Brass Company, Winnipeg, one 10,000 gallon tank; the Goodyear Tire and Rubber Goods Company, Toronto, one 10,000 gallon tank; the National Manufacturing Company, Brockville, one 7,000 gallon tank. The Dominion Steel Foundry Company, Hamilton, have duplicated an order for one 102,000 gallon vertical storage tank. The order was received on November 23rd, for completion on December 22nd. All of the above orders are being filled from stock material, shipment in no case exceeding two weeks from receipt of order.

Captain Thomas H. Byrne, 38th Battalion, who was reported wounded, has cabled to Ottawa: "Wound is not serious." This welcome news was read by Mr. John Murphy, before a recent luncheon of the Ottawa branch of the Canadian Society of Civil Engineers, held at the Chateau Laurier.

Buildings of Heavy Timber Mill Construction*

By C. E. Paul, Construction Engineer

THE marked success of early heavy timber structures of the mill construction type led to the popular use of this form of construction in practically all kinds of large buildings. As its use developed, new problems arose which made necessary a departure from the original designs. This variation to suit the case in hand finally resulted in three general classes of framing, each commonly referred to by builders as mill construction. These classes have certain basic points in common, such as heavy timber, brick, stone, or concrete walls; stairways and elevators enclosed in fireproof shafts or towers; floors with no openings or with all openings protected by fireproof covers; each floor or room isolated by means of automatic fireproof doors or fire walls; windows protected by shutters or by the use of wire glass; sprinkler equipment, etc.

These three general types of framing may be classed as follows:

1. Floors of heavy plank laid flat upon large girders which are spaced from 8 to 11 feet on centres. These girders are supported by wood posts or columns spaced from 16 to 25 feet apart. This type is often referred to as "standard mill construction."

2. Floors of heavy plank laid on edge and supported by girders which are spaced from 12 to 18 feet on centres. These girders are supported by wood posts or columns spaced 16 feet or over apart, depending upon the design of the structure. This type is called "mill construction with laminated floors."

3. Floors of heavy plank laid flat upon large beams, which are spaced from 4 to 10 feet on centres and supported by girders spaced as far apart as the loading will allow. These girders are carried by wood posts or columns located as far apart as consistent with the general design of the building. A spacing of from 20 to 25 feet is not uncommon for columns in this class of framing where the loading is not excessive. This type is more generally known as "semi-mill construction."

Each of these types is provided with a lighter top-floor, to take the wear and give a finished surface. Construction details will be given in the paragraphs which follow.

The terms "mill construction" and "slow-burning construction" are used in most instances without a true clearness of meaning. It is true that mill construction is one of the best types of slow-burning construction, but there are other types of structures which are referred to under this same classification. The popular distinction is best shown in the building ordinances of various cities. In mill construction only timbers of large size are used, but in slow-burning construction small timbers protected by metal lath and plaster or other fire-resisting materials are frequently installed. Instead of the thick floors required in mill construction, lighter material is used, with a fire retardant layer between the under floor and the wearing surface. Plaster covered steel or iron members may also form the main part of the framing in this latter type of building.

Mill construction has always been looked upon with favor for buildings in which ordinary manufacturing industries are carried on. Warehouses and buildings for storage of merchandise, stores, office buildings, factories, shops, and all buildings of moderate height which are not to be used for extremely hazardous purposes from a fire protection standpoint, are later developments of this type of construction. City building codes limit the height of building and size of open spaces in buildings. They also specify the minimum sizes of timber which shall be used, and other similar details.

This article is intended to supplement as an educational treatise and to aid technically the work of the architect or enginer who may not have the time or opportunity to compile such information for himself. While heavy timber mill construction buildings are easy to build and have the results of long experience to guide the builder, the services of a competent architect or engineer are always advisable. In no class of buildings can safety and economy of design be more positively assured.

Walls and Enclosures.

The stability of any building depends to a great extent upon the nature of the foundations and the bearing power of the soil upon which these foundations rest. Not only must the walls have footings of sufficient size, but all piers which support columns or isolated loads must also be provided with ample bearing surface. Heavy machines or equipment may be supported upon foundations which are separate from the main foundations of the buildings. This is advisable in all cases where heavy shocks or vibrations are likely to occur.

The footings and foundation walls of modern mill buildings are of plain or reinforced concrete. A lean mixture of one part Portland cement, three parts clean sand, and five parts of broken stone or screened gravel, should be suitable for footings in ordinary cases, while a 1:2:4 mixture will make strong, watertight foundation walls if the materials are carefully graded and properly handled. It is essential that the concrete be extremely well mixed.

Safe bearing values for different kinds of soil to be used in preliminary estimates are given in Table I. If exact values are needed in doubtful soils, bearing tests should be made.

Table I.—Bearing Power of Soils.

	Tons per sq. ft.
Rock	10 to 200
Gravel, compacted	8 to 10
Sand, clean and compact	4 to 6
Clay on thick beds, always dry	4 to 6
Clay on thick beds, moderately dry	2 to 4
Sand, clean and dry	2 to 4
Dry earth	1 to 2
Quicksand and wet soil	½ to 1

The unit bearing on footings should be proportioned in such a manner as to allow equal settlement under all parts of a structure. In general, footings for natural foundations should be made 1 ft. 6 in. or 2 ft. thick. If pile foundations are used, the footings should be made 3 ft. thick, with the pile head extending 1 ft. into the concrete. Foundation piles should not be spaced closer than 2 ft. on centres in any direction, and at least 2 ft. 6 inches should be allowed in one

* Courtesy National Lumber Manufacturers' Association.

direction. Wood piling should always be cut off below water level, unless creosoted. Thorough creosoting is recommended for all exposed piling.

Wherever exposed to the action of frost, footings should lie from 4 ft. to 6 ft. below grade, depending upon the climatic location. In any case, footings should be carried to the firmest bearing strata within reasonable reach.

The thickness of the foundation walls or the size of isolated piers will depend upon the load to be carried. This load is determined approximately from preliminary plans of the building, and from the weight of machinery, equipment, or materials which is to be carried on the floors of the structure. In calculating the live load, allowance must be made for the effect of impact from machines and equipment, together with the overturning effect on the leeward side, due to the wind.

If the soil is wet and a dry interior is to be assured, the basement walls and floor should be waterproofed during construction. This waterproofing may consist of a continuous layer of bituminous material placed on the outer surface of the walls, extending through the walls at the footings, and forming a tight membrane under the wearing coat of the basement floor, or by the use of a rich, properly graded mixture of Portland cement concrete containing a reliable integral waterproofing compound.

Exterior Walls.

City building ordinances, as well as the recommendations of insurance underwriters, generally specify exterior walls of an incombustible material, such as brick, stone, or concrete. The pilastered form of brick or reinforced concrete wall gives large window areas and furnishes support to the main girders of the floors where needed, but may lack the rigidity of a solid wall. This general type of construction may be carried out either in the form of curtain walls or panel walls at the choice of the designer. In the absence of a local building ordinance which determines the proper thicknesses to be used in the different parts of brick or concrete exterior walls, it is suggested that the sizes given in the Building Code Recommended by the National Board of Fire Underwriters be followed.

In small buildings or structures located well out of conflagration districts and separated from other buildings, exterior walls are occasionally made of heavy timber construction as in the case of floors. The posts which are to form the exterior framing should be of a size needed to carry the load from the floor above, but should not be less than 10 in. by 10 in. These posts should be spaced from 8 to 10 ft. apart, as in the case of the floor girders, and should be thoroughly braced at the corners of the building and around openings, to provide stiffness.

The walls may be of plank 2 in. or more in thickness. Tongued and grooved or splined material is placed vertically and nailed to horizontal girths extending between the posts. Square-edged plank may be used by covering the cracks with ½ in. battens. If metal siding or slate is to be used as an exterior finish, the planks should be placed horizontally and fastened to the posts and intermediate studs, if needed. Planks nailed diagonally will aid in stiffening the building, but there is a small waste of material involved. All interior surfaces should be left exposed, so that water may reach them easily in case of fire.

Fire and Party Walls.

Fire walls and party walls should be built of brick or reinforced concrete, and should extend three feet above roof. The thickness and general design is regulated by the local ordinance, or may be governed by the recommendations of the National Board of Fire Underwriters. For the sake of economy designers should take care to keep the floor areas of the maximum proportions at which fire walls are not required, as the cost of fire walls and the protection of openings in walls add materially to the cost of a structure. Maximum floor areas between fire walls or exterior walls of mill construction buildings not over 65 feet high, as recommended by the National Board of Fire Underwriters, are as follows:

	Without Sprinklers. Sq. ft.	With Sprinklers. Sq. ft.
Building fronting on one street	6,500	13,000
Building fronting on two streets	8,000	16,000
Building fronting on three or more streets	10,000	20,000

Local building ordinances may vary from these areas and should be consulted in any case. Many examples may be found in the cotton and woolen mills of the New England States in which these areas have been exceeded, even in the practice of leading engineers and architects. The weave room of one large mill is said to have a floor area of five and one-third acres.

Enclosure Walls.

Walls which serve as enclosures for stairways, elevators, etc., should be self-sustaining and of incombustible material. Brick walls not less than 12 in. thick or reinforced concrete not less than 8 in. thick are commonly used for this purpose. In special cases where the wall is less than 8 ft. on a side and has no openings, a brick wall 8 in. thick may be used if it does not extend more than one storey in height.

The walls of stairways and elevator enclosures when inside of a building should extend through all floors and rise about 3 ft. above the roof. No interior windows should be allowed, and all openings from the different floors should be protected by automatic fire doors. All stairway doors should be self-closing.

Belts or power drives should be located in a special tower or shaft constructed of incombustible material, as n the case of stairways and elevators. Openings to such shafts should be self-closing.

General Construction.

One of the distinctive purposes of mill construction is to obtain strength and stiffness with a minimum amount of timber surface and corners exposed to attack by fire. Large supporting members and flat, smooth, heavy floors provide this requirement. Large timbers do not ignite readily, and, if exposed to fire, burn slowly and with but slight penetration after a considerable period of time. Flat, smooth surfaces possess this same resistance to combustion, and may be reached easily by water from sprinklers or hose.

Heavy timber posts support large timber girders spaced as far apart as the design will allow. These girders support a thick main or carrying floor direct, without aid of joists or smaller timbers, except in semi-mill construction. The main floor is covered with two or more layers of waterproof paper, or similar material, to prevent leakage of water or passage of dirt from the floor above. In usual practice a hardwood top or wearing floor is laid on the paper and completes the total thickness of floor. Edge-grain flooring of other woods may also be used, while a new end-grain flooring of small blocks glued to a solid base gives promise of success.

The factor of safety used in calculations for size of girders and columns is sufficient to allow serious char-

ring by fire and still leave strength to support the floor loads. Wood posts have successfully withstood fire that would have entirely crippled unprotected cast iron or steel columns.

Beams of sufficient strength to carry the imposed leads may deflect or vibrate under the action of machinery or impact; therefore, the factors of weight, deflection, vibration, and impact should be considered in finding the dimensions of beams that may be used in a given case.

Size of Bays.

The width of floor and roof bays will vary from 8 to 11 ft. on centres where the planks of the main floor are laid flat and no intermediate beams used. If the planks are set on edge, the bays will commonly vary from 12 to 18 ft. in width, depending in any case upon the general design of the building, the amount of floor load, and an economical arrangement of the pipes for the sprinkler system. Economy in the use of lumber is effected by making the span such that the full working strength of a given commercial size of material may be utilized, and the material used in standard lengths. Excessive deflections must be guarded against in any design.

The length of bays may be as great as 20 to 25 ft., but 16 ft. is more common in ordinary buildings. Again, the design of the building and the sizes of material easily obtained determine this dimension.

Crosby and Fiske, in their "Hand Book of Fire Protection," refer to the width of bays as follows:

"Narrow bay construction (4 ft. to 5 ft. centre to centre of timbers) is not true mill construction, and is undesirable for several reasons. There are more corners, angles, and surfaces on which fire may feed and spread. Water from sprinklers or hose streams cannot be used as advantageously. Owing to the expense, and also because of the greater number of sprinklers in the same fire area, it is not always feasible to place a line of sprinklers in every bay, and if this latter is not done, the sprinkler protection is not as satisfactory. Less than 6 ft. bays are not advised, and, if used, the building should not be classed as of 'mill' construction."

Height of Storeys.

The height of different storeys of a building may be controlled by the different character of occupancy or by special processes necessary in the manufacturing industries. Where no special features are to be provided for, the heights shown in Table II. may be used as a guide:

Table II.—Height of Storeys from Floor to Floor.

Width of building.	Height of storeys.
25 feet	12 feet
50 feet	13 feet
75 feet	14 feet
100 feet	15 feet
125 feet	15 feet

The National Board of Fire Underwriters recommend that no storey of any building above the first storey shall exceed 15 ft. in height.

Fig. 1.—Heavy timber framing with laminated floor.

Minimum Sizes of Material.

Building ordinances and insurance codes or specifications have established certain minimum sizes of girders and thickness of floor plank. This action tends to preserve the distinctive points of mill construction and separate it from ordinary light framing. While all ordinances and codes do not agree in detail, the same purpose is indicated in each.

Girders or beams are commonly required to be at least 6 in. in either dimension, and often a cross-section area of 72 square inches is demanded. Some cities require 8 in. as a minimum dimension. All timbers are to be planed on all sides.

The main or carrying floor should be at least 3 in. thick, with tongued and grooved or splined joints if laid flat upon the girders. For plank 4 in. or more in thickness the edges should be grooved to take a ¾ in. by 1½ in. spline. The top wearing floor may be of a

1 in. material. All material should be surfaced on all sides. The sizes given above are nominal and not actual.

Girders.

Although a minimum dimension of 6 in. (nominal) is specified by building ordinances and insurance recommendations, girders of greater depth than width are commonly used.

Girders are preferably of single stick, but for sizes above 14 in. by 16 in. it is often advantageous to use

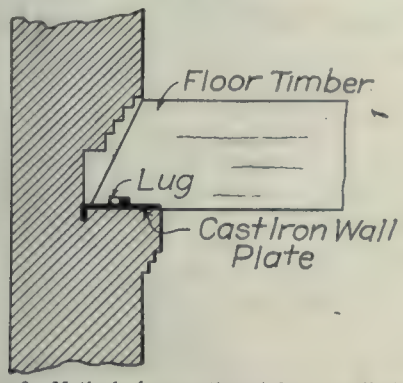


Fig. 2.—Method of supporting girder on wall plate.

two pieces 8 in. by 16 in., or a similar combination, bolted together securely side by side with the larger dimension vertical. It has been the custom to leave an air space about ¾ in. wide between the two members thus fastened, but modern practice favors placing the two girders close together without air space. It is claimed that the space between double members allows the entrance of fire into a place which is difficult to reach with the ordinary sprinkler system or even with a stream from a hose.

Bolts ¾ in. diameter fitted with nuts and 3 in. washers are often used to fasten double girders. The extreme bolts are placed about 2 ft. in from the ends, while the others are staggered at equal spacing along the length. The spacing longitudinally should not be greater than four times the depths of the girder.

Where girders meet at the columns they should be fitted around the column or butted up close to it. The ends of girders may be drawn together closely by dogs driven into the top side, or held in place by steel or iron straps spiked, bolted, or secured by lag screws, as shown in Fig. 1. If the style of post cap will allow, the sides of the post cap which project upward may be used as straps for the girders.

The length of the bearing at the ends of girders should be such that the bearing area will be sufficient to allow a suitable unit stress in compression across the grain of the wood. A minimum length of 5 in. is often required, but an exact determination should be made after the width of girder is known. If the local building ordinance specifies definite values, they should be used in all calculations.

Girders are supported at the wall by metal wall plates or wall boxes built into the wall, as shown in Fig. 2 and Fig. 3, thus distributing the loads more evenly on the brickwork. Wall plates should have two flanges—one to anchor the plate to the wall and the other to hold the girder on the plate. Care should be taken to see that a ½ in. air space is left around the ends of girders for ventilation, so as to prevent the appearance of dry rot. A preservative treatment applied to the wall ends of the girders will give added security. It is advisable to allow end play in girders to prevent strains in the walls. Ends of girders should be cut at an angle such that in case of damage by fire the member may tip out of the wall opening without disturbing the wall. At columns, girders are supported by steel or iron caps.

Use of Intermediate Beams.

Where intermediate beams are used to support a floor in semi-mill construction it is preferable that the beams should rest on the top of the girders direct. The width of the main girder is usually sufficient to give ample bearing for the ends of the beams in the bays on each side of the girder, even when the ends butt together. Common practice is to suspend intermediate beams between the main girders by the use of steel or iron stirrups or hangers. This practice undoubtedly lowers the cost of the side walls of the building owing to the diminished height of wall needed at each floor. This type of construction is not looked upon with favor by insurance underwriters. They claim that experience has shown that such stirrups or hangers are likely to prove hazardous during exposure

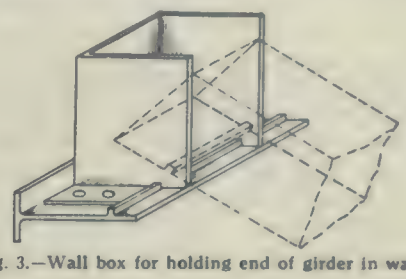


Fig. 3.—Wall box for holding end of girder in wall.

to fire, either causing the heavy timbers to burn off quicker at the point of suspension in the stirrup or hanger or allowing the beams to fall, due to the failure of the metal stirrup or hanger itself.

The Crosby-Fiske Hand Book of Fire Protection contains the following comment upon this point:

> "Mill construction, particularly in the Middle West, has suffered unfairly in reputation by reason of disastrous fire results, because buildings somewhat resembling this type have borne its name. They may have had floors and roofs of plank or wide-spaced timbers, but in other particulars violated the principles of 'mill construction.' A common defect has been the use of exposed steel or iron stirrups to hold important floor timbers."

(To be continued).

Sheet Steel for Pavement

A town in the United States is trying out the use of steel sheets as a paving surface. On one of its streets, a roadway 7 inches thick is being built, consisting of a macadam base 4 inches in depth, covered with 3 inches of concrete. A wearing surface of steel plates is used which measure 18 feet long, 30 inches wide and ⅛ inch thick. Trapezoidal-shaped perforations, 2 x 1½ x 1¼ inches in size are placed throughout the plate at 1 to 1½ inch intervals. The shorter side of each perforation is uncut and the metal is bent down to form a projecting lug on the under side. Connection between adjacent sheets is formed by fitting tongues on one side of one sheet into slots in the opposite side of the other sheet.

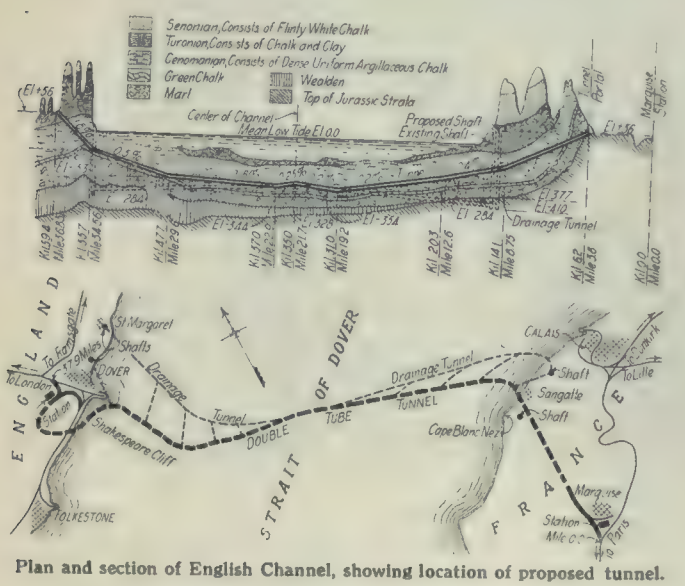
The steel sheets were placed in position and tamped to a solid bearing, with the tops flush with grade. Each steel sheet was joined to the one already placed by raising the outer edge and slipping the tongues of the new sheet into corresponding slots of the other plate. The new sheet was then lowered, and at the same time pushed close to the other sheet. A space of about one-eighth inch was left between adjacent sheets.

Actual cost data on what has been done shows a unit cost of $2.00 per square yard.

Tunnel Between England and France

The war has changed public opinion and shown the value of such a project—Extensive investigations have already been made.

A REVIVED interest in a channel tunnel between England and France has resulted from the present war. For nearly a hundred years proposals have been introduced from time to time for a means of linking up the two countries by a tunnel driven under the strait that forms the existing barrier to land communication. Both French and English companies have been formed with a view to carrying out the scheme, and as a matter of fact work was started about forty years ago on preliminary headings from both sides. The value of such an undertaking has always been appreciated in France, but British sentiment has, in the main, been antagonistic to the plan. The object lessons of the war, however, are apparently changing public opinion, and there is every indication that the plan is now meeting with favor and may be crowned with ultimate success. The facilities which such a tunnel offers for transportation, together with the independence from sea traffic, are important considerations in view of the present dangers to cross-channel transportation from enemy war vessels and submarines. It has recently been intimated that the whole scheme will be reintroduced in the British House at an early date, and on account of



Plan and section of English Channel, showing location of proposed tunnel.

the revived interest shown in the venture we believe our readers will be interested in a presentation of the main facts concerning the work and the proposed plans for its construction. We are indebted chiefly to Engineering Record and The Engineer for the facts and illustrations in connection with this article.

Scheme Long Delayed by British Opposition

The scheme for establishing a physical connection between England and France across the Straits of Dover is an old one, a French engineer having suggested it to Napoleon as early as 1802. Serious proposals for a feasible project, however, began with the French engineer, Thome de Gamond. Passing over Gamond's early proposals, which date back to 1834, and include a sheet-iron tube sunk on the bottom, an $80,000,000 bridge, two five-mile riprap jetties between the ends of which a ferryboat would operate, a riprap causeway with three drawbridges, and his first tunnel scheme proposed in 1856, the first plan which formed the basis of definite action was proposed by him in 1866. This plan resembles the present one, except that it included a construction shaft and permanent station on an island to be made at the site of the Varne shoal in mid-channel. An Anglo-French committee of six was constituted in 1869 to carry out this plan, and although most of its original members are dead the committee is still in existence with full authority. After the war of 1870 the plans were modified by omitting the island station, which was considered too vulnerable to an enemy fleet.

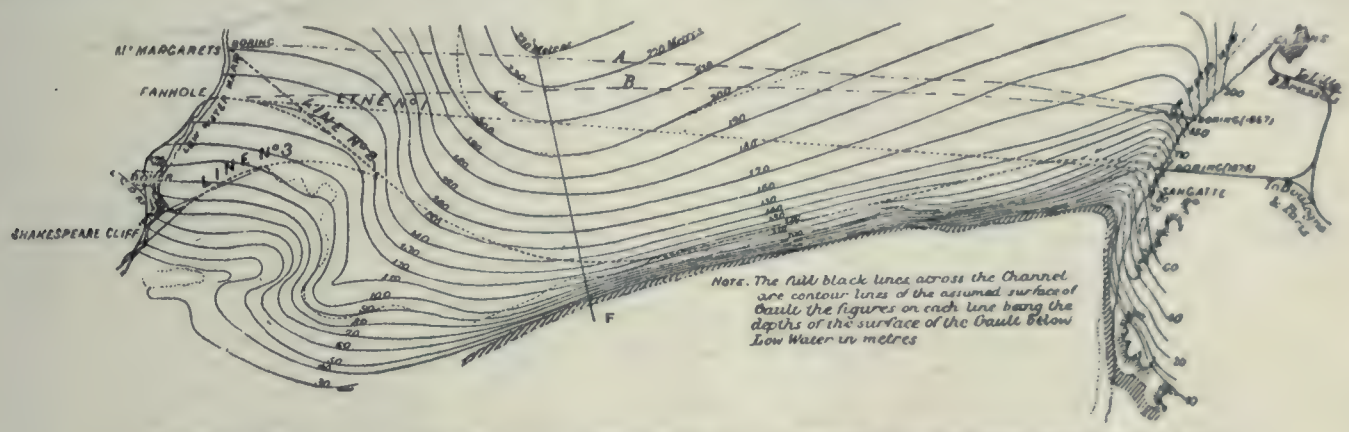
Boring machines tried out at that time were expected to complete this tunnel in four or five years at a cost of $40,000,000, and the net annual revenue from freight and passenger traffic was expected to reach $10,000,000. It was the intention to operate trains with compressed-air locomotives, and Gamond had worked out a scheme for compressing the air required by using the rise and fall of the tides. A French company was created by an act of August 2, 1875, with a ninety-nine-year franchise to construct the French half of the tunnel and co-operate with a similar British company in carrying out the plans to be finally adopted by the commission above referred to. This company raised and spent more than $400,000 on shafts, soundings and borings. It constructed a trial tunnel 7 feet in diameter, 6,033 feet long from the French shore. Its construction plant and underground workings have been maintained in good condition and the company is ready to go ahead with the completion of the project.

The British meanwhile had organized in 1872 the Channel Tunnel Company, which was merged by an act of July 16, 1874, into the Southeastern Railway Company. This company co-operated with the French company and spent $200,000 on exploration. It was succeeded within a short time by the Submarine Railway Company, which excavated two headings from the English shore, one 2,641 feet and the other 6,075 feet long. The shafts from which these tunnels were driven were sunk in the Shakespeare Cliff near Dover. This company was later merged into the Channel Tunnel Company, Limited, which has maintained the early construction work and plant. Its tunnels have been pumped for a long period, and have shown a remarkably small quantity of seepage.

In 1875 Gamond died, believing that his project was to be put into immediate execution. However, popular outcry, led by London newspapers, definitely put a stop to continuation of the work in 1882. The Conservative party succeeded in defeating motions made to resume construction in 1883, 1887 and 1906. It is interesting to note that at the last-mentioned date the French proposed, as a concession to England, to build a long section of the tunnel approach as an elevated railroad along the French coast, so that the British fleet could readily destroy it on occasion. As

Dumas points out, this plan at present would scarcely appeal to the British mind. Were such a line in operation to-day, raids by enemy destroyers, submarines or sea planes would perhaps be able to keep it out of commission a good part of the time.

In spite of the opposition across the channel the project has never been lost sight of in France, and the plans have been revised and kept up to date until the present project, in many of its essential details, is practically a new one. Albert Sartiaux, chief engineer of the Compagnie du Chemin de Fer du Nord, and for some time a director of the French construction company, the Societe Francaise du Chemin de Fer Sous-Marin, has been in charge of the engineering work and is responsible for the present plans.



The proposed line for the tunnel deviates from a straight course so as to lie wholly in an impervious chalk layer and have a minimum variation in grade. It follows approximately the contour lines of the stratum illustrated above.

Geological surveys of the channel, confirmed by the explorations already made, indicate that the proposed tunnel will meet nothing resembling the tilted and faulted strata which caused such great difficulty in the construction of the Simplon tunnel and which resulted in the temporary loss of an entire heading while the Astoria gas tunnel under the East River in New York City was being built. The theory commonly accepted among geologists is that an isthmus connected France and England during the Miocene period and that subsequent settlement has caused the formation of a shallow strait. The indications are that this settlement was very gradual, and was not attended by any faulting or folding. The strata found on both sides of the channel correspond very closely in thickness, position and material. At the top is the well-known white chalk in which flint occurs, underlain by a stratum of chalk and clay. Beneath this in turn is a bed 200 feet thick of compact argillaceous chalk which is very uniform and dense. It is extensively quarried for the manufacture of cement and corresponds to the gray chalk found at Rouen in France. This material, while it does not require timbering, is rather easy to excavate and is nearly watertight. Soundings indicate that it maintains a uniform thickness for the entire distance under the channel, and lies approximately between elevations indicated on the profile. The latest plans contemplate a thorough exploration of this bed from the drainage drifts, which will be constructed first, and a vertical alignment of the tunnel, which will not require leaving this stratum except at the ends. The outcrop of this bed on both shores has determined the location of the line and of the junction stations shown on the plan.

The present plans call for the construction of twin single-track tunnels 18 ft. 4½ inches in diameter and 67 ft. 7 in. centre to centre. The total length of the line from the junction with the Paris-Calais road to that with the railroad from London to Dover will be a little more than 37 miles of double track, about 32 miles of which will be in tunnel. The location on the French side, which is more definitely settled than that on the British, contemplates a maximum grade of 1 per cent., while a grade of 1.8 per cent. is shown on the present plans at the British end. A short hump about four miles in length is planned at the middle of the channel, from each end of which water will be taken through drainage tunnels to pumping stations at shafts sunk on shore on either side. The two drainage tunnels will be connected with the main tunnels by cross-drifts dividing the latter into excavation sections four or five miles in length, which can be constructed independently of each other.

From experience with the trial drifts constructed, the seepage in the main tunnels is not expected to exceed 8 gallons per minute per 100 lineal feet of single-track tunnel, or 26,500 gallons per minute for the entire length of both tubes, which is well below the quantity of water pumped in many of the deep mines of Europe.

Tunnel to be Built in Sections

The French half of the work is naturally divided into two sections, the first of which includes the station and approach and the first 4½ miles of tunnel, which can be drained through the existing shaft. The construction plans contemplate building the remainder of the French section by first driving the drainage tunnel, from which three cross-tunnels will be excavated to the line of the main tunnels. From the end of each of these cross-drifts and from the end of the drainage tunnel at mid-channel the excavation of the main tunnels will be started upgrade, all of the spoil being taken out through the drainage tunnel and the main shaft. During the construction of the drainage tunnel and cross-drifts it is proposed to drill test holes up and down at intervals of 500 feet, to define exactly the limits of the stratum in which the tunnel will be constructed. This exploration work may result in modifying the proposed profile shown herewith.

Tunnelling machines modelled on that invented by Colonel Beaumont and thoroughly tried out on the British side of the strait will be used to drive both the main tunnels and the 10-ft. drainage tunnels. It is expected from the past performance of this machine that a progress of 3.7 miles per year can be made for each machine in use, provided the muck can be disposed of. With all the headings working, this would require the transportation of 4,400 tons of material

daily through the section of drainage tunnel next the shaft. The French engineers expect to accomplish this with an electric railroad of 2-ft. gauge (presumably double-track), over which 100 train movements a day in each direction will be necessary. This estimate also allows for transporting in and out 1,200 workmen daily. A very large shaft will be necessary to accommodate hoisting equipment capable of raising material to the surface at this rate. Experience indicates that the shaft on the French side will be difficult to sink, and it is expected that the pneumatic process, grouting or freezing, or perhaps a combination of all three, will be required.

Based on this estimate of progress in the headings it would take three years to drive the drainage gallery to the centre of the strait. In the meantime work would have started, at some of the four points of attack provided for, on the main tunnels. It is expected that by this method the entire work can be completed in 4½ or 5 years. The work on the British half of the tubes will be carried out along much the same lines, although the construction scheme for this half of the work has not yet been gone into so thoroughly as that for the French side.

Electric Operation Decided On

As was to be expected, the contemplated use of compressed-air locomotives has been abandoned for electric operation. Numerous breaks in grade will not constitute a disadvantage with electric traction, and consequently it is planned to change the profile of the tunnels, as may be required, to insure keeping them well within the impervious stratum. It has been estimated that the train movements would be sufficient to ventilate the tunnel, but the plans provide in addition for two 300-h.p. ventilators, each capable of changing the air in the tunnel once in three days without assistance from train movements.

Venture Likely to Prove Profitable

Although it is estimated that the project would cost in excess of $2,000,000 per mile, a figure not approached by any other railroad tunnel in Europe, it is believed that the operating revenue to be derived from the enterprise would make it a profitable one from the outset. It would be possible, if terminal facilities could be provided to load them, to move 144 troop trains a day in one direction. If 1600-ton freight trains (representing about a 50-car train in American practice) were hauled, a possible volume of 225,000 tons of freight a day could be handled on the same basis. As the most recent estimate of Sir Douglas Fox places the cost of the English half of the tunnel at $31,655,000, and as Albert Sartiaux estimates that the French half can be built for $34,740,000, the net annual revenue from such maximum traffic at prevailing rates would represent a large fraction of this estimate for the entire cost of the project.

Estimated Construction Cost $77,000,000

To be on the safe side M. Sartiaux has supposed that the entire construction cost will amount to $77,000,000, and has made a conservative estimate of the proportion of the present freight and passenger traffic across the channel which would be diverted to the new line. On this basis 440 to 550-ton trains would be the standard for freight traffic, and fifteen freight and passenger trains would be operated each day in each direction. The net revenue on this traffic would yield 5 to 7 per cent. on the sum invested. A similar estimate published by Baron Emil d'Erlanger also places the net annual earnings of the road at $5,400,000, which represents about 7 per cent. on the maximum expenditure contemplated.

The tunnel, if constructed, will have a far-reaching effect in cementing French and English commercial relations. The line would bring Paris and London closer together by 5½ hours against the best running time that can be made at present. Another important saving would be the elimination of the double transfer from rail to water and back to rail, which is necessary at present, and a saving in the time required for the transit of freight shipments probably much greater than the saving in passenger time.

Tests on Electrolytic Sewage Treatment

THE results of interesting experiments recently made on the efficiency of electrical treatment of sewage are described by Mr. Edward Bartow, Director Illinois State Water Survey, in a recent issue of Engineering Record.

The Illinois State Water Survey was invited on July 12 to "co-operate with and assist the city to whatever extent it may feel able to or disposed" in the official tests of the "electrolytic lime" sewage disposal plant, built at Decatur by the Electrolytic Sanitation Company of Illinois. Analyses developed the fact that the purification by treatment with lime alone was greater than that obtained in several of the individual samples treated with lime and electricity.

An outline indicating some of the items to be considered in determining the efficiency of the plant was prepared and submitted to the chemists who were to conduct the tests on the ground. The following items were suggested:

I. Cost of Installation.—(a) Comparison with cost of installing plants of other types.

II. Cost of Maintenance.—(a) Power for the mechanical operation; (b) power for the electrolysis; (c) lime and other chemicals; (d) labor; (e) interest and depreciation; (f) disposal of sludge: 1, Sludge pressing; 2, moisture in sludge; 3, hauling of sludge; 4, land required for disposal.

III. Efficiency of Plant.—(a) Effect of electrolysis; (b) effect of lime; (c) effect of sedimentation (sedimentation capacity necessary); (d) quality of effluent measured by total residue, organic nitrogen, putrescibility, oxygen consumed, alkalinity (to phenolphthalein and methyl orange); (e) comparison of quality of effluent with reported effluents obtained by other processes.

It was impossible for the Water Survey to obtain data concerning all of the items enumerated. Some have been discussed in the report furnished by the chemists and engineer, but others have not yet been given sufficient consideration. The report shows the estimated costs of installing the electrolytic-lime purification plant, but does not give data showing a comparison of the cost of treatment with the cost by other types of sewage-purification plants, especially plants

which might obtain an effluent of the same quality, as, for example, chemical precipitation with lime.

The Water Survey has also been unable to obtain estimates of the cost of maintenance, and can only form conclusions from the results furnished by the chemists and engineer of the company. In these estimates we note especially the high value given to the sludge. We have been unable to confirm the statement through correspondence with manufacturers of fertilizer. It is our belief that the dried sludge containing about 1.6 per cent. nitrogen (N) would have little, if any, value, and would probably be disposed of only at considerable expense to the city.

Samples of raw sewage and of the final effluent were obtained and brought to the State Water Survey laboratory for analysis. At the conclusion of the official test the plant was run for a short time without electricity. One visit was made during this period and samples collected for examination. Additional samples would have been taken when the plant was running without electricity, if the company officials had not ordered the plant shut down.

Lime Alone Better at Times.

The results of the analyses have been compared, as shown in the accompanying table. When lime alone was used, less lime was added than on any of the days when lime and electricity were being used.

The raw sewage was approximately of the same concentration. That treated with lime alone was weaker than the average if measured in terms of total residue, suspended solids, dissolved residue, and total organic nitrogen, but stronger if measured by ammonia nitrogen and oxygen consumed. The purification by treatment with lime alone was greater than that obtained in several of the individual samples treated with lime and electricity. The alkalinity to methyl orange did not show as great a decrease when lime alone was used, indicating the use of a smaller proportion of lime and confirming the figures obtained by weighing the lime. Measured in terms of oxygen consumed, the reduction was greater with lime alone, though in some individual cases greater reduction was obtained with lime and electricity.

Company Objects—Quits.

We regret that because of the objections of the company we were unable to obtain further samples when the plant was running with lime alone. While it is unsatisfactory to draw conclusions from a single test with lime alone, yet the results obtained are better than some of the individual results obtained with lime and electricity. This would indicate that a series of tests would show lime to be as efficient as a combination of lime and electricity. After the test with lime alone the city insisted that there should be a comparative test of one week's duration with lime and electricity and of one week's duration with lime alone.

This test was started on Oct. 23, using lime and electricity. Composite samples were taken to be analyzed in triplicate by the chemist of the company, the city chemist, and the State Water Survey. After five days of operation the test was discontinued by the company and the plant ordered to be dismantled. The city will, however, install sufficient apparatus to test the effect of lime on the Decatur sewage.

Analyses of Samples from Decatur Sewage Experimental Plant
(Chemical Results in Parts Per Million)

Date	Nitrogen: Ammonia Raw.	Nitrogen: Ammonia Eff.	Nitrogen: Total Organic Raw	Nitrogen: Total Organic Eff.	Nitrogen: Nitrite and Nitrate Raw	Nitrogen: Nitrite and Nitrate Eff.	Solids: Total Raw	Solids: Total Eff.	Solids: Suspended Raw	Solids: Suspended Eff.	Solids: Dissolved Raw	Solids: Dissolved Eff.	Alkalinity Raw	Alkalinity Eff.	Ox. Cons. Raw	Ox. Cons. Eff.	Methylene Blue Eff.	Lb. lime per mil. gal.
Sewage Treated with Electricity and Lime																		
July 24	26.4	12.0	....	...	...	1.0	1,840	1,487	245	62	1,595	1,425	364	146/360	302	185	15 hr. at 20 deg. C.	*
Aug. 4	46.0	11.2	....	...	0.5	0.3	1,515	1,550	460	[illegible]	1,055	1,530	460	200/380	164	174	10 min. at 20 deg. C.	3,149
Aug. 11	28.0	12.0	....	...	0.7	0.2	1,505	1,405	190	[illegible]	1,315	1,345	440	120/140	160	[illegible]	5 min. at 20 deg. C.	3,757
Aug. 19	36.0	14.0	188	82	1.2	1.2	1,970	1,549	[illegible]	67	1,679	1,482	320	116/160	[illegible]	291	.....	3,433
Aug. 20	24.0	12.0	136	76	1.0	1.0	2,830	1,653	517	66	2,213	1,587	320	132/200	[illegible]	235	.....	2,600
Aug. 20	72.0	15.0	[illegible]	75	0.8	1.8	1,537	1,508	165	[illegible]	1,372	1,424	520	108/192	212	215	.....	....
Aug. 20	42.0	13.0	70	75	1.6	1.6	2,159	1,524	[illegible]	40	1,778	1,484	440	96/208	260	270	.....	..
Aug. 25	28.0	24.0	....	...	0.32	1.6	1,548	1,417	[illegible]	24	1,332	1,393	340	64/324	[illegible]	182	Decolorized in few minutes.	....
Aug. 25	28.0	20.0	....	...	0.64	2.0	1,576	1,385	224	[illegible]	1,352	1,365	360	80/284	[illegible]	186		
Average	36.8	14.8	104	77	0.75	1.2	1,809	1,498	299	47	1,520	1,448	369	118/227	249	211		
Average per cent removed	...	59.8	....	26	...	..	17.2	....	84.4	..	...	4.73	.	42.7	...	15.3		
Sewage Treated with Lime Alone																		
Oct. 6	48.0	27.2	54.4	46.4	1.4	1.1	1,581	1,354	313	26	1,268	1,328	512	124/488	264	178	Decolorized in few minutes.	2,400
Oct. 6	36.8	24.8	41.6	55.2	1.0	0.9	1,436	1,336	198	45	1,238	1,291	468	112/440	260	168		
Average	42.4	26.0	48.0	50.8	1.2	1.0	1,508	1,345	255	35	1,253	1,309	490	118/464	262	173		
Average per cent removed	...	39.0	Increase, 3.8		...	..	....	10.8	...	86.4	Increase, 4.3		...	5.3	...	34		

*Amount of lime from Mariner & Hoskins' report of official test.

The Purington Paving Brick Company, of Galesburg, Ill., has become a licensee of the Dunn Wire-Cut Lug Brick Company, of Conneaut, Ohio, and will engage extensively in the manufacture of Wire-Cut Lug brick. The Purington Company is one of the biggest paving brick concerns in the United States, with a daily output capacity of about 350,000 brick. The Purington organization consists of F. G. Matteson, president and treasurer; George C. Prussing, vice-president; C. D. B. Howell, vice-president; W. H. Terwilliger, secretary; W. G. D. Orr, general manager.

The Privy Council has confirmed the judgment of the Court of Review awarding Evarest Champagne, formerly manager of the Montreal Public Service Corporation, Ltd., $17,500 damages against the company for breach of contract. Mr. Champagne was engaged as manager of the company for a period of years, but before the time expired he complained that, although nominally manager, he had been superseded and shorn of all power. Thereupon he took action against the company for breach of contract, claiming $199,000 damages. Subsequently, on an amended claim, he asked for $35,000 damages, representing five years' salary as manager. A judgment of the Superior Court, rendered by Mr. Justice Panneton, gave him $17,500 damages. The company then took the case to the Privy Council and again lost.

Mr. E. I. Shuttleworth, one of Ottawa's most prominent contractors, died recently at the age of 44. His illness was only of short duration, pneumonia being the cause of his death.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Gilbreth Adjustable Scaffolds Aid Construction on Whitby Insane Hospital

A feature that distinguishes the work of construction on the new Hospital for the Insane, now under erection at Whitby, Ont., is the number of schemes and devices that have been developed to save expense or reduce time and labor. One of these is the different methods of scaffolding, which show labor-saving ideas and have been designed to secure the most efficient results at low cost. One of the most extensively used types of scaffold is the Gilbreth scaffold, illustrated herewith. By the use of this scaffold the walls and

The Gilbreth adjustable scaffold being used in the erection of a wall.

partitions were built up without need of the usual pole or trestle scaffolding and at a considerable saving in cost and time. At the same time the Gilbreth scaffold was adjustable, and accommodated itself to the progress of the work.

As shown in the illustration, the essential parts of the scaffold are a stationary upright standard and a movable and adjustable scaffold support. The standard, "A," consists of two upright wooden scantlings, fastened to a base and braced. Holes through the standard at 10 in. centres enable the scaffold to be adjusted to suit the location of the work. The scaffold support slides between the uprights and, as shown in the cut, there is provision on this support for three sets of planks. The arm "B" carries the scaffolding for the bricklayer to stand on; the arm "C" supports planks to allow hod-carriers or laborers to bring material. A secondary scaffold is carried on the arm "D" to hold the bricks, tiles, and mortar. The units are set up on the floor or on planks to secure a level foundation at 12 to 14 ft. centres. The standards are braced by iron rods, one on each sde. The rods are hooked to the upright about 2 ft. above the base and nailed to the floor planks at the lower end.

The movable trestle is raised one notch, or 10 in., at a time as the work proceeds. This is done by means of a special jack of the automobile type. A bolt slipped through the hole at "E" holds the frame in place. The scaffold can be raised to a limit of 14 ft.

A scaffold of this type cannot be used on the outside for building up the entire wall since the limit of its height is only 14 ft., but it is used on the inside, and after the first storey is erected and the floor joists or beams of the upper floor set, the scaffolds are re-erected on the second floor.

This scaffold eliminates the use of poles and trestles and makes a neat arrangement. One feature of it is the fact that the brick and materials are at the right height for convenient working, and it is claimed that a saving in time has been noticed since workmen do not have to stoop. Time is also saved in that the scaffolds are raised without stopping the workmen. The ease of adjustment is, of course, one of the main advantages, and the fact that the units are instantly available and easily transported are commendable features. The scaffolds were manufactured by the Government, at a cost of about $3.50 per unit.

Pavement Squeegee Made from an Old Hoe

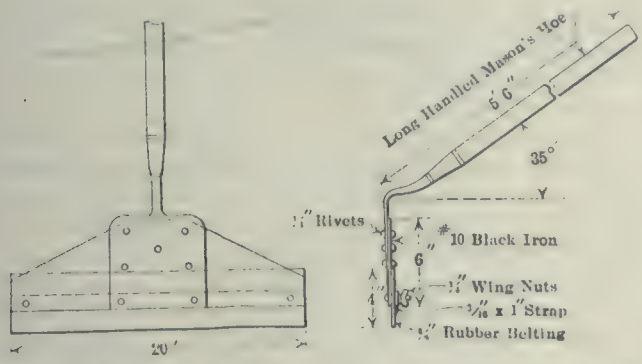
The application of cement grout joint filler in granite block pavements has always required careful attention to detail. The last or finishing coat is undoubtedly the most important, and the usual method of applying it by brooming a comparatively thick mixture into the joints has generally been accompanied by the spreading of a coat of grout from ⅛ in. to ¼ in. thick over the whole surface of the pavement. Attempts to leave the surface of the blocks practically free from mortar and still keep the joints full of grout generally meet with failure where brooms are used, as the bristles pick the grout out of the joints unless a thick mixture and fairly heavy coat are applied with a broom having quite soft bristles.

The heavy coat on the surface is somewhat wasteful of material, but greater objections to it result from the rather slow reduction of the coating to dust and the action of toe calks on horses' shoes in picking of the grout in such a way as to cause its removal from the tops of the joints. With grout so removed, the corners of the block are unprotected, and they wear round very rapidly.

Similar troubles have not usually been experienced

with grouted brick pavements, and the now prevailing practice of using squeegees for applying the finishing coat in grouting brick, combined with the comparatively smooth finish of modern granite blocks, has led to the use of squeegee for final grouting work on granite pavements also.

The results obtained experimentally by the Brooklyn Rapid Transit System last year with the squeegee



An old hoe makes a squeegee for grouting joints in granite block pavements.

in track pavements have warranted its adoption as a part of the tool equipment of every track gang, which is also equipped for pavement work. The illustration gives the details of such a tool, which is being used to advantage in Brooklyn. Its manufacture is simple, and the use of old, badly-worn hoe blades effects some salvage. In passing, it may be noted that the Borough of Brooklyn now requires the use of a squeegee for grouting work in new granite pavement where cement grouted joints are specified. This description is by R. C. Cram in the Electric Railway Journal.

An Extensive Sewage System Proposed for Ford, Ont.

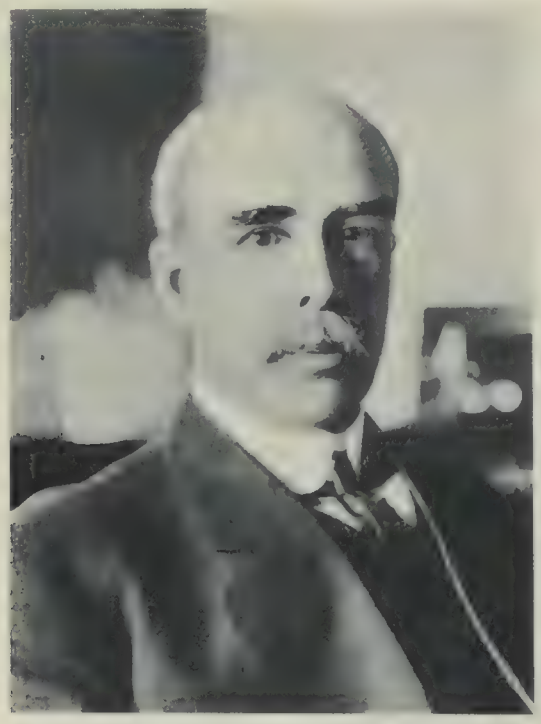
A report was recently submitted to the town council of Ford, Ont., by T. A. Murray, consulting engineer, regarding the proposed sanitary sewage system for the municipality. The estimated expenditures, as itemized in the report, are as follows: Sewers, $66,973; disposal plant, $28,000; pumping plants, $12,000; flushing tanks, $600; engineering services, $5,378; incidentals, $1,000; total, $113,951. The amount for the laying of sewers is arrived at by estimating $1.50 per foot for 8.4 miles of sewer, which covers practically the whole of the town. The streets on which it is proposed to lay mains are as follows: Sandwich, Ramo, Dawson, Lawrence, Ottawa, Pellette, Elrose, Joseph Janisse, Parent, Strabane, Belle Isle, Cadillac, Drouillard, Maisonville, Hickory, Charles, Albert, St. Luke, Francis, Edna, Montreuil, Alexander, Albert Lane. The plant, as proposed, will be laid out in units, so that it may be added to from time to time until it has been increased to a capacity sufficient for a population of 15,000. The engineer recommends that the installation be made to take care of a population of 5,000. The flushing tanks included in the estimates are two elevated automatic tanks of 750 gallons each. Their addition to the system is considered necessary, in view of the fact that there is not a sufficient flow of water available without them to flush the sewers properly. It is also proposed to install two automatic pumps underground at different points on Sandwich Street in order to raise the sewage to the required level for the disposal plant. The estimated cost of one of the pumping stations is $8,000 and of the other $4,000, while their maintenance charges would be about $500 per year. As possible alternatives to

(Continued on page 1160).

Architect's perspective of Amity street girls' school, a description of which appeared on page 1125 of the November 29 issue of Contract Record. Vandal & Gascon, Architects.

Major Dennis Nominated for President of C.S.C.E.

Major John Stoughton Dennis, C.E., D.L.S., assistant to the President of the C. P. R., with offices in Montreal, has been named by the nominating committee as the President of the Canadian Society of Civil Engineers for 1917. He was born in Weston, Ont., in 1856, and is the son of the late Lieut.-Col. John Stoughton Dennis, C.M.G., Deputy Minister of the Interior, Ottawa. After being educated at Upper Canada College and the Royal Military College, Kingston, he was engaged on Dominion land surveys in Western Canada, and for four years was surveyor to the Hudson Bay Company's land department, which he organized. Major Dennis then went into private practice as surveyor and engineer in Winnipeg, and later was appointed inspector and chief engineer of surveys, Dominion Government, and from 1894 to 1902 was chief engineer of the Irrigation Department and Surveys, Dominion Government, and Deputy Commissioner of Public Works, North West Territories, 1897-1902. In that year Major Dennis was appointed superintendent of Irrigation and Land Commissioner for B. C. for the C. P. R., being promoted to assistant to the second vice-president in 1904. In 1910 he was made manager of the company's irrigation and land interests in Alberta. Recently he was appointed assistant to the president, and removed from Calgary to Montreal.



Major John Stoughton Dennis.

Major Dennis joined the Canadian Society of Civil Engineers in 1901 and has served a term as a vice-president of the society and also as a member of the council. He is a past president of the American Society of Irrigation Engineers; holds a commission as Dominion land surveyor Dominion Topographical Surveys, and a first class military school certificate.

The Vancouver and Districts Joint Sewerage and Drainage Board have decided to let only half the big interceptor sewer at the West End by contract and to do the other portion by day labor. The contract for section 5 C has been awarded to H. P. Peterson, and section 5 B will be done by the board by day labor, under the supervision of its engineer, Mr. A. D. Creer.

Personals

Mr. G. N. Houston, for the past three years a member of the Calgary Branch, C. S. C. E., has returned to Denver and reopened his office as consulting engineer.

Mr. A. S. Dawson, acting chairman of the Calgary Branch, C. S. C. E., has recently returned from El Paso, where he delivered an address before the International Irrigation Congress.

Mr. William Pearce, President of the Calgary Branch of the Canadian Society of Civil Engineers, who has been in Ottawa for several months in connection with his duties on the Economic and Development Commission has returned to Calgary.

Lieut. Col. H. R. Lordly, M.C.S.C.E., of the 5th Pioneers, Montreal, has been presented with a case of binocular glasses on behalf of the Cornell University Association of Eastern Canada, of which he was one of the founders. Mr. W. H. Wardwell, C.E., the president, made the presentation.

Mr. C. R. Needs, Assoc. Mem. C.S.C.E., civil engineer, who since the outbreak of war has been an inspector of munition plants with the Canadian Inspection Company, principally of plants at Galt, Ont., is leaving for England, having enlisted in the Canadian Aviation Corps. Prior to the war Mr. Needs was resident engineer of the Canadian Northern Railway.

Lieut. Claude Cecil Wimperly, eldest son of Mr. H. Wimperly, Oakville, Ont., has been reported wounded. Lieut. Wimperly trained at Toronto, going overseas with the 116th Battalion. In England he was given a commission in the 75th Battalion and went to the front with a draft from that unit. He was in his second year at the School of Practical Science, Toronto, when he enlisted.

It is announced that Capt. W. G. MacKendrick, 235 East Roxborough Street, Toronto, has been appointed Assistant Deputy General Director of Roads in France. Capt. MacKendrick, who was president of the Warren Bituminous Paving Company of Ontario, enlisted for active service at the outbreak of the war and went overseas with the first Canadian contingent. For some considerable time he has been in charge of road construction work under the general headquarters staff of the British forces in France. Capt. MacKendrick's son was killed at the front a few months ago.

Mr. Howard Murray, vice-president and treasurer of the Shawinigan Water and Power Company, Montreal, has joined the staff of the Imperial Munitions Board, and will be associated with the management of the explosives branch. The directors have given Mr. Murray a year's leave of absence. Mr. Julian C. Smith, the chief engineer and general superintendent, has been appointed general manager of the company. Mr. Smith has been responsible for the design of several important hydro-electric developments, including that of his own company and the hydraulic section of the Cedars Rapids plant.

Mr. S. G. Porter, secretary-treasurer of the Calgary Branch of the Canadian Society of Civil Engineers, has just returned from an extensive visit through the Western and Southern States. He reports that engineering and construction activities are increasing at many points. This was especially noted at El Paso and Houston, Texas. At Houston, Mr. E. E. Sands, formerly engaged in irrigating engineering in Western Canada, and now city engineer at Houston, stated that during the past three years his department had expended $7,000,000 on public works. He is now engaged in the construction of docks at the terminus of the new ship channel, a modern sewage disposal plant, storm sewers, pavements, etc. During the trip Mr. Porter addressed the Colorado Branch of the American Society of Civil Engineers at Denver, The International Irrigation Congress at El Paso, and the students of Baylor University at Waco, Texas.

Mainly Constructional

East and West—From Coast to Coast

The Quebec Legislature have passed a vote for $250,000 for colonization roads.

The annual meeting of the Calgary Branch, C. S. C. E., for the election of officers will be held on December 2nd.

The brick and tile manufacturers of Elgin County, Ont., and the adjoining counties, have announced advances in the prices of their products.

The Dominion Steel Corporation is said to be enjoying the greatest prosperity in its history. The entire steel output of their plant has been sold for 1917.

Albert W. Richardson, a builder and contractor, of Vernon, B.C., has made an assignment of his property, to be sold for the general benefit of his creditors.

The C. P. R. propose to erect a large dormitory in connection with the Algonquin hotel at St. Andrews, N.B. This addition will cost some $60,000 or $70,000.

Two new theatres have been built in New Glasgow, N.S., this season, and over one hundred residences. The permits for the year number 109, as compared with 36 in 1915.

Mr. J. W. Dorsey on November 8 read a paper on "A cut-out system on party telephone lines," before the Electrical Section of the Manitoba Branch of the Canadian Society of Civil Engineers.

Bathurst, N.B., has experienced a very active building season this year. Stores and residences have been improved and erected, besides which a church has been built and additions made to another church and an hotel.

Conditions in South Vancouver, B.C., are said to be better than they have been for a considerable time, and building contractors have been pretty busy with alterations and repair work on houses, due to people moving into the district.

The Canadian Malleable Iron Company are making an addition, 40 x 60 feet, concrete construction, to their plant at Owen Sound, Ont. A few weeks ago another addition, of a more or less temporary nature, 30 x 100 feet, was made to the munition department.

The contractors for the foundation of the new government grain elevator at St. John, N.B., are pushing forward their work. One line of track has been laid to the elevator site. The new elevator will have an initial capacity of 500,000 bushels; later on its capacity will be doubled.

An investigation of the Water Department of Fredericton, N.B., has been ordered, and it is stated that several changes in the management of the department may be made. The results being obtained at the pumping station, both from the pumps and the filtration plant, are said to be unsatisfactory.

The Union Cement Company's plant at Owen Sound, Ont., is now being shut down for the winter. It has been necessary to close the works earlier than was at first intended on account of the scarcity of coal. The company have had a very satisfactory season, having sold practically their whole output.

Official announcement has been made by Hon. Dr. Reid that an order-in-council has been passed for the construction of two vessels in British Columbia to be placed on the line between the Canadian Atlantic and British Columbia ports, via the Panama Canal. Contracts are to be let immediately by the Department of Railways.

The Steel Company of Canada, Limited, Hamilton, Ont., contemplate considerable additions to their plant, according to an announcement recently made by the directors. In view of the earnings of the company, a distribution of four per cent. on the ordinary shares of the company has been authorized, to be paid out of the earnings of the year 1916.

The growth of St. John, N.B., is being very clearly shown by the demand for additional school buildings. This demand is in part being met by the erection of a Catholic High School building on Cliff Street, and of a $70,000 building on Bentley Street. In the adjoining district of Lancaster another school building has also become a necessity.

The new steel ship under construction at Wallace Shipyards No. 1 in North Vancouver for the Kishirito Company, Japan, is fast taking form. The frames have been erected and the double bottom finished. Work on the four wooden vessels at the No. 2 yards is also progressing satisfactorily, and the first of them will be launched by the New Year.

The Nova Scotia Steel & Coal Company are now building as the latest addition to their plant at New Glasgow a large steel foundry, which will obviate the necessity of ordering steel castings from the United States for use in the car works, and will be of similar advantage in the steel ship building industry which they have recently undertaken. A big building is now under construction and will be rushed to completion.

According to a recent announcement of the Lake Superior Corporation, their output for the ensuing year is practically sold up. At October 31, the company had approximately 380,000 tons of unfilled orders on hand, the tonnage preponderating being shell steel and steel rails. Two new 75-ton open hearth furnaces are being installed and should be completed by the end of the year, when the steel plant should be able to produce about 45,000 tons of ingots monthly.

The embargo placed by the C. P. R. upon stone, cement, lime and other building materials has had the effect of a partial tie-up in the building trade. Even after the lifting of the embargo the contractors claim they are unable to get cars to move the materials, no improvement in the situation being apparent. Inquiries indicate that there are buildings in many centres being held up because materials could not be obtained. An appeal may be made to the Dominion Board of Railway Commissioners for relief.

A deputation representing 42 municipalities have asked the Quebec Government to construct a road from St. Lambert to Levis, connecting it with the King Edward Highway from Rouses Point. The Premier replied that the Government were unable to do this, as it was imperative to curtail the expenditure on good roads. He advised the different municipalities interested to construct whatever part of their respective roads they could and if they did so the government would only be too happy to assist them all it could.

The plans of the Essex Border Utilities Commission to utilize the Windsor waterworks temporarily to supply the border towns were presented to the Windsor Water Board recently by Morris Knowles, consulting engineer for the Commission. Engineer Knowles declared the plan to be a very satisfactory one from an engineering point of view, in that it would save the Windsor plant from being scrapped until the original plan of obtaining a supply from up the river was approved by the ratepayers. The suggestion, however, did not meet the approval of the Windsor officials.

A petition was recently received by the city council of St. Catharines, Ont., from a number of building contractors, requesting certain changes in the building by-law. It was suggested that the use of hollow concrete block be permitted in foundations. City Engineer Near stated that more difficulty had been experienced with the concrete block foundations than any other class, and that the hollow block

would be the most difficult to inspect. The by-law, he said, was a great protection to purchasers, and to weaken it would be a retrograde step. It was finally decided to amend the by-law to permit the use of concrete blocks in foundations; the "hollow" was, however, struck out. The request for the amendment was made in order that building work could be continued during the cold weather.

Mayor Porter, of Ottawa, has laid before the board of control of that city a project for the enlargement of the city hall. He suggests that the $300,000 surplus in the sinking fund, or as much of it as is required, be utilized to pay for the work, and that additions be built at the rear of the hall from Albert to Queen Street, back to Canal Street, to accommodate the police station, a hall of justice, a juvenile court, the present number eight fire station, and to provide extra space for some of the civic departments. The proposal received favorable consideration by the members of the board, though the matter is, of course, merely in a preliminary stage.

Thomas Kelly, the Winnipeg contractor, who is now at Stoney Mountain penitentiary serving his sentence, has appealed to the Minister of Justice against his conviction. His petition is a lengthy document which contains a recital of all the events in connection with his extradition, arrest and trial. He claims that in the investigation the rules of evidence were disregarded and that his case was prejudiced by the campaign carried on by the Liberal press. He also complains that he was not given sufficient time to prepare his case. Reference is made to an alleged change in the Jury Act by the Norris Government whereby the Crown was able to summon an unlimited number of jurymen and choose twelve suitable to themselves.

At a recent session of the council of Lanark County, Ont., the road work which has been performed was reviewed and discussed. Lanark was one of the first counties to take advantage of the Ontario Good Roads' legislation, and at the end of the present year it will have about 125 miles of county roads. In addition to this, all the tolls have been taken off, and a number of bridges assumed by the county which formerly had to be built and maintained by the municipalities in which they were located. At the close of 1915 Lanark will have expended $225,000 in the construction of good roads under the Ontario Highways' Act, and next year will see still more roads taken over by the county. Over $11,000 has been expended since the first of the year on maintenance in connection with the county road system.

At the present rate of progress the new Union Station at Toronto will probably be completed early in the year 1918. The steel work is nearing completion and the stone work on the Front Street side of the structure has been commenced. There is some doubt as to when the building of the railway viaduct in connection with the depot will be undertaken. The railway companies have requested the city to defer the construction of this viaduct for fifteen years and offered to build bridges across the tracks at York, Bay and Yonge streets. An official states that even though the city bring the companies before the Dominion Railway Commission and compel them to pay the maximum penalty of $100 per day, until the viaduct is completed, they will prefer to pay this fine rather than undertake the work, as it would amount to much less than the interest on the necessary outlay.

The new Grand Trunk shops at Port Huron, which are to replace the old shops destroyed by fire some time ago, will cost about one million dollars. They will be used principally for the repair of freight and passenger cars and will consist of the following structures: a power-house containing six 150 h.p. boilers serving double steam generating units of 300 kw. for developing the electric power for lighting and operation of machines, all of which will be motor driven; a passenger car shop of two units 135 feet by a combined length of 545 feet, accommodating 27 modern passenger cars, with a transfer table 80 feet long between the two units; a freight car shop, 160 x 360 feet, accommodating 70 freight cars; a cabinet shop of two floors, each 73 x 250 feet; a blacksmith and machine shop, 150 x 300 feet; a wood mill, 90 x 210 feet; a dry-lumber shed, 47 x 147 feet; a storehouse 61 x 154 feet; and an office building 61 x 64 feet. These buildings, including trackage, will occupy a space of approximately 55 acres.

Obituary

Alexander Laird, of Toronto, died recently in that city at the advanced age of 84 years. Mr. Laird came to Canada from Scotland as a boy, settling at Elora, Ont., where for 35 years he worked with his father in the stonemason trade.

Lieut. Corin Henry Cooper, of the Royal Engineers, is reported dead of wounds. Lieut. Cooper was engaged in government survey work in the Rockies at the beginning of the war. He was a graduate of McGill University, Montreal, where he acted as demonstrator.

Pte. Ernest N. Simons, previously reported wounded, is now said to have been killed in action. He was only 19 years of age and was the son of Mr. A. F. Simons, of Toronto. He was in business with his father, who is a drain contractor, when he enlisted in the 58th Battalion.

Mr. H. W. Aird, manager of the Canada Paint Company, died suddenly at his residence on Elm Avenue, Montreal, recently. Only a week previous he had returned after assisting at the jubilee convention of the associated companies, the Canada Paint Company and the Sherwin-Williams Company, at Cleveland, Ohio.

Mr. E. T. Nesbitt, contractor and lumber dealer, of Quebec City, died in the Montreal General Hospital on November 23, after a brief illness, aged 62 years. He was a prominent citizen of Quebec, and participated in many public movements. Mr. Nesbitt was particularly interested in matters connected with the building trade, and was for several years president of the Quebec Builders' Exchange, being a member at the time of his death.

The death occurred recently of Mr. Albert Brewer, an old and respected resident of Woodstock, N.B. Mr. Brewer entered the contracting business as a young man, his first work being on the old New Brunswick Railway, when he had charge of the construction of the old bridge between Woodstock and Grafton. He also built several other bridges in different parts of the province, and, with Messrs. S. Perly and John Hopkins, did considerable railway grading work both in New Brunswick and Maine.

An Extensive Sewage System Proposed for Ford, Ont.

(Continued from page 1157).

the plan of pumping the sewage to the level of a disposal plant at a distance from the river front, it was suggested that use might be made of the Walkerville sewers, or that a system of treatment might be installed at the river front. Both these plans, however, were discarded as impracticable. The report specifies sewer pipes of vitrified earthenware, and recommends that sewers which have already been installed by the town be used for surface drainage when the new system is completed. The project will be submitted to the ratepayers at the next municipal elections, provided it is not blocked by opposition from the Essex Border Utilities Commission, should they consider it to conflict with their plans for a joint system.

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Engineers Report Montreal City Scheme Works Out at $1,515 Per H.P.

A TRULY remarkable state of affairs in Montreal has been exposed by the "Committee of Ratepaying Engineers," on the expenditures necessary to carry out a power development in conjunction with the Montreal water supply system. It had been originally estimated that there would be available some 10,000 h.p., but the report shows this figure to be much too large, and places the maximum at 7,000 h.p.

The startling feature of the report, however, is the statement that "the minimum cost of the project as designed will be $10,600,000." This cost is exclusive of the filtration works or any pumping plant or steam auxiliary, or any allowance for parking or the usual allowances for contingencies. The minimum capital cost, based on the maximum safe capacity of the plant, would therefore amount to $1,515 per horse power.

Now, the city of Montreal is the centre of one of the most abundant power areas on the North American Continent, and as such can obtain by purchase such power as it needs at very reasonable rates. The report in question states that 24-hour power can readily be purchased for from $20 to $25, so that, taking the higher figure, the 7,000 h.p. would not cost more than $175,000 per annum. As against this the engineers' report calculates the carrying charges, if the proposed development is carried through, at $757,000, estimating interest at 5 per cent., sinking fund at 1 per cent., and the usual depreciation rates. The latter scheme, therefore, would cost the city annually close to $600,000 over and above the cost of the purchase of power.

* * *

That the estimate of the Board of Ratepaying Engineers is reliable is perhaps best evidenced by the personnel of the board, which includes only well-known members of the Canadian Society of Civil Engineers. If further proof were necessary, one has only to compare the estimated cost of this installation of $1,515 per horse power with other hydro-electric installations in Montreal, or, for that matter, anywhere in the world. Take, for example, the plant of the Cedars Rapids Manufacturing and Power Company, recently completed in Montreal. The last annual report gives the bonded issue of this company at approximately $10,500,000 and the development at about 100,000 h.p. This is a cost per h.p. of $105. Doubtless, too, there are many plants on this continent installed around this figure. The Niagara plants, for example, are probably little in excess of this amount, and possibly one of them less. Indeed, from the Atlantic to the Pacific it is safe to say there is not a modern installation developing hydro-electric power that has cost more than $200 per horse power in capital charges.

* * *

When one considers these cases one realizes more forcibly the enormity of the mistake the city of Montreal has been persisting in. Much money has already been spent on the scheme, but that is no reason for continuing the work. Even if another five or six millions were to be spent on it and the installation completed, it would still probably pay the city handsomely to allow the plant to stand idle and purchase from one of the companies operating in that city.

Incidentally it may be recalled that this report was furnished by the engineers "gratis"—a refreshing and encouraging contrast to the schemes of profiteering that one sees around him in every direction these days. We hope the whole situation is an omen that engineers and engineering methods and ideals will in future have more to say in the management of affairs of national importance which, in the past, have been so much mismanaged by our (sometimes) well-meaning but too often incompetent "politicians."

Government Bill Dealing with Roadway Making and Maintenance

The Quebec Government has introduced the promised bill dealing with roads. The main object is to make provision for the maintenance of the roads, many of them built under the Good Roads Act. At the roads conventions the importance of maintaining as well as building roads has been very strongly urged, it being pointed out that it was largely a waste of money to construct highways and to allow them to get into such a state of disrepair as to be of comparatively little

value. It is self-evident that the life of a neglected road will be short, and that it is as important to maintain the highways as it is to construct them. The bill, it is reported, proposes to classify roads into two divisions—provincial and municipal. The government will be responsible for the construction and maintenance of the provincial roads, and will charge the municipalities with a portion of the cost of the upkeep. The maintenance of the municipal roads will be done by local authorities, but the work will be subject to supervision by officials of the government roads department. The government, however, will contribute towards the cost of the upkeep of the municipal roads.

British Columbia Stone a Superior Material

President T. R. Nickson, of Sechelt Granite Quarries, Ltd., Vancouver, has had a considerable force of men at work at Hardy Island taking out granite blocks for the new Canadian Northern Railway terminal station on False Creek, the first storey of which is being built of that fine material. The stone is transported on scows from the up-coast quarry, and is shaped and dressed at a plant on Main Street, in the rear of the station site.

From the ground storey up the facing material will be sandstone similar to that used in the construction of the Parliament Buildings at Victoria and Provincial Court House and Merchants' Bank Building at Vancouver. This splendid stone, which blends perfectly with granite, comes from immense deposits on Haddington Island, about 220 miles north of Vancouver. President Nickson has already sent up gangs of men and equipment to open up the quarries there.

Experts have pronounced the Haddington Island sandstone to be the best deposit of that class of building material on the American continent, and superior to the Ohio sandstone, so largely used in the Eastern States and Eastern Canada. British Columbia builders are fortunate in the possession of such excellent materials for the finer examples of architecture, the demand for which will multiply as our cities grow older and wealth increases. A word might also be said in favor of our marble deposits, which promise infinite possibilities when developed along right lines.

Sulphate of Iron Replaces Alum in Water Filtration

Sulphate of alumina as a coagulant in the purification of water can be effectively replaced by sulphate of iron at a considerable saving in cost, according to results obtained from experiments carried out in Clarksburg, Va., U.S.A. Sulphate of alumina has always been supplied as a coagulant, with the use of lime when necessary to increase the alkalinity of the water. The greatly increased price of this material led the waterworks board to make a trial of sulphate of iron and lime for coagulation. In this particular plant, since no provision has been made for a mixing chamber, the chemicals are introduced in the pipe line carrying the water from the river to the coagulating basin. The lime enters the line about 50 feet ahead of the alum. The same plan was used when iron was substituted and a good floc was produced. The water can be given a secondary treatment with iron only, just as it enters the second half of the basin, so that all the fine material is certain to be coagulated, sufficient lime being introduced at the outset to allow for this. Six months operations have shown that the iron sulphate is quite as effective as the alum and that a clear, sparkling fluid results, with widely varying original turbidities. The cost is very materially reduced, the saving being very nearly two-thirds. Since using iron and lime the quantity of hypochlorite of lime to sterilize the filtered water has been increased by three to four pounds per million gallons.

Melted Snow Forms a Water Supply

A project is being undertaken in the state of Arizona whereby an arid desert district is to be watered with the melted snows of a neighboring mountain range. The scheme involves a collecting ditch located in an impermeable clay stratum to intercept the water flowing down the mountain slopes, with two storage basins evolved from old volcanic craters. Pipe lines totalling 90 miles are to be laid to serve the area. The capacity of the two reservoirs amounts to 920,000,000 gallons, and the total annual supply will be 2,000,000,000 gallons. The distribution will take place entirely by gravity. The pipes are of sheet iron, each length having a bead or ridge stamped around each end. The end of one pipe is heated to enable it to slip over the adjacent pipe, with the hollow bead of one fitting over the raised ridge of the other. On cooling, the pipes are locked together. The total cost of the installation is estimated at $250,000.

This will solve the difficult problem of supplying water in this district, where all potable water has to be drawn in by rail in tank cars. So little water was available that in some towns the effluent from treated sewage was used to sprinkle lawns and in boilers.

The Oxy-Acetylene Blow-Pipe

The oxy-acetylene blow-pipe has solved one of the difficult problems in connection with cast iron water mains. Its use has facilitated the removal of the lead caulking from the joints. It often becomes necessary to take out a section of a main for repair or to insert an elbow, tee, or fitting in the line. The old method of removing the lead caulking by hammer and chisel takes a man a day or more on any fair-sized pipe, besides entailing constant danger of damaging the pipe. This method is both expensive and unsatisfactory. The flame of the oxy-acetylene blow-pipe is a solution to the difficulty, and the lead can be removed in an hour or so. A small tip is used that gets right into the crevice, so as to confine the flame to the lead without injuring the pipe itself in any way. This method is economical and inexpensive, besides being convenient and usually quite accessible.

The International Manufacturing Company, said to be a subsidiary of the International Arms and Fuse Company of America, have commenced operations on a million dollar plant near Dominion Park, Montreal. The building will have a ground floor area of 350 x 750 feet, and is being erected by Anglins, Limited. Work has been under way for about three weeks, and it is understood the building will be ready for occupation not later than the end of January.

A new engineering society, under the name "The British Columbia Institute of Civil Engineers," has been formed in Victoria, B.C. The new association is wholly a provincial one, and has no connection with other societies of a similar nature. The following have been elected officers: Chairman, Mr. E. N. Horsey; secretary-treasurer, Mr. L. Macrae; under-secretary, Mr. F. M. Preston; council, Messrs. Stokes, Devey, Noakes, Mitchell, Lambert, and Todd.

Culverts and Bridges on Concrete Highway

Between Toronto and Hamilton—Their Beauty and Stability Evidenced by Accompanying Photographs

By A. E. Wynn, B. Sc.*

IN Canada probably the principal engineering work of the future will be the improving of our highways and the building of new main roads. An important branch of this work is the design and construction of the bridges and culverts.

Owing to the increase in traffic and the use of heavier vehicles a higher standard of highway construction must be adopted, and as a modern, improved road is only as strong as its weakest part, it is necessary that all the bridges and culverts along the route conform to the same high standard as the pavement itself.

Twenty-six foot arch, Toronto-Hamilton Highway.

The construction of the Toronto to Hamilton highway is one of the first important works of this kind to be undertaken in Canada, and this article purposes to give a description of the work that had to be done and the method used to put the bridges and culverts into permanent shape.

As concrete is becoming recognized as one of the best materials to use for main road surfaces, so also is concrete now used almost exclusively for building the structures under the roadbed, as this is the only material that is permanent and requires no maintenance.

The first thing done was to get a complete description of every bridge and culvert along the route, and soundings were made to ascertain the nature of the foundations. There are forty-one culverts and small bridges between the Etobicoke River and Hamilton, and it was found that every one would either have to be replaced or extended. Of the existing types many were timber boxes or rubble walls with timber decks. These were all replaced. Those that were built of concrete had to be examined for their capability to carry the increased loading, and some were so badly cracked, due to poor workmanship, that they also had to be taken out and replaced. The smaller bridges were light steel trusses, old and not strong enough to carry modern traffic; so they were removed and new structures built.

The standard width of the roadbed is 26 feet, and as the existing concrete culverts were seldom wider than 18 feet, every one had to be extended. Through the village of Port Credit extensions were made to 66 feet, the full width of the right of way, to allow for any future requirements. In some cases the new centre line departed considerably from that of the old travelled road, or, in order to improve the grade, a heavy fill was necessary over the culvert, so that extensions had to be made to meet these conditions. Where divergences were made, entirely new structures were necessary. In all 21 new structures were built, and 20 were extended from 10 to 40 feet.

Types.

All timber boxes were replaced by reinforced concrete boxes of standard design, with the same size of opening or larger where thought necessary. For all spans up to 10 feet this type of culvert was used, as it is the most economical, easy to construct, and gives the maximum opening. For spans greater than 10 feet either girder construction or arches were used, the former when the foundations were too bad for an arch or where the rise was high and the span small.

Two light Warren truss bridges were replaced by reinforced concrete arches of 25 and 50 feet span respectively. Another steel truss was replaced by a girder and slab structure of 20-foot span, and two new bridges of this type, 20 and 16-foot spans, were also built.

Extensions in general were of same type as existing culverts, mostly arches varying from 10 to 30 feet in span. Where the fill was not greater than three feet, the spandril and wing walls were carried up nine inches above grade to form curbs. Where the fill was greater than this, the culverts were extended to catch a 1½:1 slope, the width of roadbed being increased to

Twenty—six foot bridge east of Oakville—Concrete fence posts in foreground for placing cattle obstructions.

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about 30 feet. Wing walls in nearly every case were built parallel to centre line of highway, and of reinforced concrete. Where the stream crossed the centre line at an acute angle, splay wing walls of plain concrete were used. The parallel type gives a neater appearance to the culvert, is more economical, and easier to construct.

All exposed edges were chamfered and the walls finished off with a coping 12 inches deep. Concrete

A 50-foot span—the longest arch on the route.

inverts were built in all cases where there was likelihood of scour. A standard form of guardrail, consisting of concrete posts and rails, was used on all culverts where a guard was necessary. As much as possible uniformity in appearance was aimed at.

Design.

All culverts and bridges were designed for class "C" loading of the Ontario Highways Department's specifications, which is for heavy and concentrated traffic, the uniform live load being taken at 135 pounds per square foot, together with a concentrated load of a 20-ton steam roller or motor truck. The working stresses used were 650 pounds per square inch for extreme fibre of concrete for bending, 60 pounds per square inch for concrete in shear, and 16,000 pounds per square inch for tensile stress in reinforcing steel. Reinforced concrete was used practically throughout in preference to plain concrete, steel at this time being cheap, and, as with all these culverts, transportation costs were high, owing to long hauls, a saving in cost was effected by having less material to haul.

Box Culverts.

Box culverts were of two types. Where good foundations were found, the simple box form was used, and it was assumed that the invert and walls bore the same uniform load as the slab, and were designed as simple beams. The thickness of the walls was generally equal to that of the slab, never less; the slab steel was bent down at the ends into the wall. When it was necessary to carry the foundations deeper, the side walls were continued down and given separate footings on good-bearing material, and aprons were built each end of the invert. Where the bed of the creek was rock the invert was left out.

Small arches were built of plain concrete, no economy being effected by reinforcing. Arches 25-foot span and over were reinforced with three-quarter per cent. of steel to take temperature stresses and prevent cracks, the line of stress being kept within the middle-third of the arch ring. Arch abutments were always founded on rock.

Girder and slab construction was used for three new bridges and four extensions. Where the necessary extension was small, this method was the most economical, a reinforced concrete girder being built either side to old structure, carrying a thin slab resting on the old walls. A 30-foot arch was treated in this manner, the girders being carried by the existing wing walls, an extension of six feet taking only 14 cubic yards of concrete. The new girder bridges were of the deck type, the 8-in. slab being carried on five reinforced concrete girders 5 ft. 7 in. apart.

The width between curbs was 26 feet, and the slab formed the finished roadway, expansion joints being placed between it and the road proper. The thickness of the slab varied from 7 in. at curbs to 9 in. at crown, and was reinforced with ⅝-in. round bars spaced 6 in. on centres, alternate bars being bent up over the girders. The girders were 12 in. x 32 in., reinforced with 1 in. round bars; half the bars were bent up at the ends and hooked into the abutment. Stirrups of ⅜ in. round bars were spaced vertically along the girders and wired to the horizontal bars. Part of the slab was taken in with the girders for "T" action.

Wing walls for practically all culverts and bridges were built of reinforced concrete, being designed as cantilevers. They were about 10 in. thick at top, with a batter of 1 in 24 on the back. Where the walls came up to grade, the top width was increased to 17 in. for a depth of two feet, to form curbs and carry the guardrail. The steel used in footing and walls was ½ in., or ⅝ in. round bars, spaced according to the height of fill. In all walls and slabs temperature steel was provided at right angles to the main reinforcement, to prevent cracks from expansion or contraction. Wing walls not parallel to centre line of highway were built of plain concrete in order to give a better bond to the abutments.

A standard design for guardrails was used, consisting of concrete posts and rails. The posts are 8 in.

Fifty foot arch, showing railing construction.

square, half round at the top, and 4 ft. 3 in. high, one foot being embedded in holes left in the curbs to receive them. They are spaced a maximum of 7 ft. 6 in. apart, are reinforced with four ¼ in. bars, and each post receives two rails 12 in. apart, the lower rail being 12 in. above the curb. The rails are 6 in. deep by 4 in. wide, reinforced with five ¼ in. bars.

A test load distributed over 6 in. at the centre, with

the 6 in. face uppermost, showed that the rail would carry a steadily-applied load of 1,400 pounds before cracking. This guardrail is cheaply constructed, is easy to erect, and has a neat appearance. In all reinforced concrete work a mixture of 1:2:4 was used. The materials used were similar to those used in the road surface, and standard tests were frequently made. All reinforcing steel was plain round bars, shipped in the lengths required.

Special Work.

A few of the bridges are worthy of special notice. The largest structure built by the commission up to the present is a reinforced concrete arch of 50 ft. span, about three miles west of Oakville. It replaces an old Warren truss on masonry abutments. The arch is three-centered, and has a rise of 9 ft. 6 in., with a fill of 12 in. at the crown. The crown and springing thicknesses are respectively 16 in. and 32 in., and reinforcement consists of 1 in. round bars 12 in. on centres on both faces. The steel only takes a small amount of tension, the line of stress practically passing through the middle third. Temperature bars were spaced every two feet and wired to main bars, helping to keep them in position while pouring concrete. The abutments are 12 ft. thick at base and are 2 ft. down in shale rock. The spandril walls are reinforced with ½ in. bars, and are well anchored to the arch ring. The wing walls are parallel to the centre line of the highway, forming curbs 26 ft. apart and 90 ft. long. They are finished off on the face with a coping 15 in. deep.

All the walls have panels 2 in. deep, and panelled pilasters 3 ft. wide are carried up on either side of the arch to the coping, and continue above to form posts of same width. The guardrail is the standard design. All the concrete was poured in freezing weather, the material being heated and steam kept in the forms until the concrete had set. The exposed surfaces were well spaded, no plastering and little rubbing down being necessary. The bridge took 360 cubic yards of concrete.

Near Burlington a bridge of 16 feet span was necessary to carry the highway over Big Gut Gulley. The foundations were very bad, it being practically a marsh, so that a girder bridge was the only type that could be used. Piles were driven down 35 feet to rock, under the abutments and wing walls. The deck in this case was covered with 12 in. of fill and panelled parapet walls were built on the outside girders. The bed of the stream being mud, in order to prevent scouring under the abutments it was necessary to provide a concrete invert, and as this had to carry a possible head of seven feet of water, it was designed as reinforced concrete slab and girder construction, the end girders being carried down to form aprons.

The most difficult extension to make was that to Triller Bridge, near Bronte. The existing structure consisted of two concrete arches, 30 and 12 ft. spans, connected by concrete retaining walls 13 ft. high and 175 ft. long. To improve the grade of the road a fill of

Coleman bridge—Only structure on pile foundation.

3 ft. over the whole length was necessary, and the standard width of roadbed was 6 ft. greater than the distance between the walls. The walls were in poor condition, several bad cracks existing, and they could not be relied upon to carry alone the extra fill. As they had been built at considerable expense, it was not desired to cover them up with a fill; also the smaller arch was a right of way, and could not be closed. The only method was to buttress the walls and carry the extension of three feet in either side by girders resting on the buttresses. The walls were filled over as far as the small arch, where wing walls were built. Buttresses, designed to carry considerable pressure from the fill, were built over the worst cracks. The girders varied from 14 to 31 ft. span and carry a 6 in. slab from the top of the old walls. The existing wing walls of the 30 ft. arch were raised three feet, and they carry the end girders. This construction improved the appearance of the retaining walls, at the same time strengthening them.

Triller bridge after widening by girder extensions on buttresses as shown.

Construction.

Construction was commenced in July, 1915, continued all through the winter, and all the culverts and bridges were finished by March, 1916. Winter work was undertaken in order that the fills would have time to settle before laying the concrete pavement in the spring, the extra cost being more than offset by having no expense of hauling plant and material back to fill in

gaps in the pavement. The work was divided into four sections, one or two gangs building all the culverts in a section.

Material was transported from the commissions' material yards at Port Credit, Oakville, and Waterdown, in summer by the dinkey train and in winter by team. All reinforcing steel was cut, bent, or welded at the yards.

Along the whole route shale rock is very near the surface, so that, with a few exceptions, there was no difficulty in obtaining good foundations. In all cases they were carried down below the frost line.

Where a concrete invert was necessary, the stream was either diverted or carried along a flume, or the culvert was built in a new position adjoining the old one. No special finish was given to the concrete, but care was taken in spading the surfaces, and only rubbing with carborundum brick was necessary. Faced ship-lap lumber was used for all exposed surfaces, kept wet while pouring or greased for the larger structures. The wall reinforcement was placed while the footings were being poured, and all bars were wired together in position before erecting the wall forms. Walls and abutments were poured together in horizontal layers.

The posts of the larger arch centres were founded on concrete fills, so that there could be no settlement or danger from sudden freshets. Arch rings were poured simultaneously from each springing; at the end of the days' work cut-offs were placed perpendicular to the arch. The decks of girder bridges were poured in one operation, no break being allowed between girders and slab.

Weep holes were left in wing walls at junction with footing. In winter each gang was equipped with a boiler, and all material was heated, and steam was used for thawing ice and snow and keeping the concrete warm until set. No stoppage was necessary because of the frost, and the work was as satisfactory as that done in the summer. The guardrails were all cast in the Oakville yards during the winter.

Cost.

All the work was carried out by the Toronto-Hamilton Highway Commission by day labor, under the supervision of the commissions' engineers, and the costs compare favorably with the average cost of this class of work. As the greater part of the construction was done during the winter months, unit costs were necessarily higher than for the work done in the summer, averaging about 15 per cent. more, but this was economical, as the extra cost was saved in the spring, in being able to lay the pavement through without a break. It was also possible to keep employed a portion of the organization required for the 1916 roadwork. The average unit cost of concrete for all the culverts was about $12 per cubic yard, material and labor costing about the same. In addition, important items were pulling down the old structures and providing temporary crossings to keep the road open to traffic. In winter the extra cost is principally due to the labor of heating material and concrete and the cost of coal. Most of the culverts being a long way from the material yards, transportation costs were heavy, amounting to about 15 per cent. of the total cost per cubic yard of concrete. The culverts and bridges contain about 3,000 cubic yards of concrete and 80 tons of reinforcing steel.

Perhaps the most interesting point in the work is that it was carried out just as successfully in winter as in summer, and with little extra cost. All that is necessary is thorough supervision and inspection, to see that all footings and forms are cleaned from ice, that no frozen material enters the mixer, and that the concrete is kept warm and protected from frost until it gains its initial set.

Austin A. Briggs, of Dunlop Tire & Rubber Goods Co., Visits Alaska

Mr. Austin A. Briggs, the advertising manager of the Dunlop Tire & Rubber Goods Company, Toronto, has returned from a very delightful business trip through Canada, including a visit to Alaska. Speaking of his trip to a representative of the Contract Record, Mr. Briggs said that next to the kindness of the Western Canadians, the most outstanding impression upon his mind was the antiquated immigration regulations kept in force by the United States, and applied to that territory. The same regulations that existed at the time of the gold rush of 1898, seemed to prevail still. The majority of the people going to Alaska, Mr. Briggs said, are Americans and Western Canadians, the majority of them tourists. Canadians from the East did not seem to have the time, even when they were West, to go to Alaska, though it was well worth while. The best time for a tourist to go to Alaska was in the month of June.

Mr. Briggs paid a tribute to the services of the C. P. R. and the G. T. R., who operate modern boats and obtain the largest part of the traffic. As a Canadian passing through the country, Mr. Briggs had a feeling of regret that the coast line should be American territory, and no longer Canadian. Along the coast line, valuable fishing industries were being operated, the majority of the fishermen being Japanese. There did not appear to be much trade possibilities outside of fishing and mining. The copper mines in Alaska were fast being developed. The scenery was magnificent, though in some places wild and monotonous.

Mr. Briggs visited the western branches of his company at Victoria, Vancouver, Calgary, Edmonton, Saskatoon, Regina and Winnipeg, and toured the country in the vicinity of the branches to get a grasp of the opportunities for business in their particular lines. As a result of his visit he was quite enthusiastic about their Western Canada organization and the prospects for still bigger business.

Owing to the scarcity of labor the construction of La Loutre dam, on the St. Francis River, for the Quebec Streams Commission, has been delayed, and the contractor, Mr. Madden, of Quebec, has made arrangements for the work to be carried on throughout the winter. About 55 per cent. of the construction has been done, which leaves 100 feet of the dam to be yet built.

Mr. E. Hanson, A.A.I.E.E., M. Inst. Mun. E., has been appointed secretary of the Institute of Municipal Engineers (London, Eng.) for Western Canada. It is the intention to inaugurate a campaign for members amongst municipal engineers in the West, with a view to securing closer co-operation amongst municipal engineers of all classes and furthering the cause of municipal engineering throughout Western Canada.

The Turbine Equipment Company, Limited, Toronto, have been awarded a contract by the town of Mimico to supply and install their sewage pumping machinery. Two pumps will be direct connected to Canadian Westinghouse motors, and a third unit to a 40 h.p. gasoline engine.

Buildings of Heavy Timber Mill Construction (Continued)

By C. E. Paul, Construction Engineer

Floors.

Floors may be of dressed and matched or splined plank 3 in. (nominal) or more in thickness, nailed direct to the girders. This type of floor is often called a "mill floor." If heavy loads are to be carried on long spans, planks 6 in. or 8 in. wide are set on edge close together, firmly nailed at each end and at about 18 in. intervals with 60 D. nails, alternating top and bottom, thus forming a "laminated floor." Each of these floors is covered with two or more thicknesses of waterproof paper or similar material and then by a top or wearing floor, laid at right angles to the direction of the under-floor. Material is surfaced on all sides and edges of plank beveled to serve as a finish on the ceiling below.

Where plank floors are laid flat the boards should be two bays in length, if possible, and laid to break joints every 4 ft. With laminated floors it may be difficult to obtain plank two bays in length. A strong and stiff floor will result if the planks are laid with the ends extending between centres of girders with one plank lad across the girder at frequent intervals (every sixth or eighth piece) to act as a tie in the floor. Or, by another method, the ends of planks should join at or near the quarter point of the span between girders, taking care to break joints in such a way that no continuous line across the floor will occur. Fig. 4 shows an instance of this kind, in which the span between girders is 16 ft. and the planks are 16 ft. long. The method of lamination shown in Fig. 4 is as follows:

Every fourth piece of plank extends from centre of girder to centre of next girder. Next to this piece of plank a second piece of the same length is nailed, with the end spaced at a quarter point of the span between girders, thus allowing one end of the length to project three-fourths of the way across one span and one-fourth way across the other. The next piece of plank is placed over the opposite girder in the same manner that the previous is placed over the first girder. The lamination is completed by placing a length of plank from centre of girder to centre of girder as in the first case. Care is taken to see that each plank is nailed firmly in place with a tight joint between each piece of the floor.

In laying laminated floors it is advisable to omit the last two planks at walls until after glazing and roofing have been completed. Then these spaces should be filled in close against the walls. It is often recommended that laminated floors be laid without nailing to the girders which support the floor, so that expansion in the floor due to dampness will not cause movement in the girders at the walls.

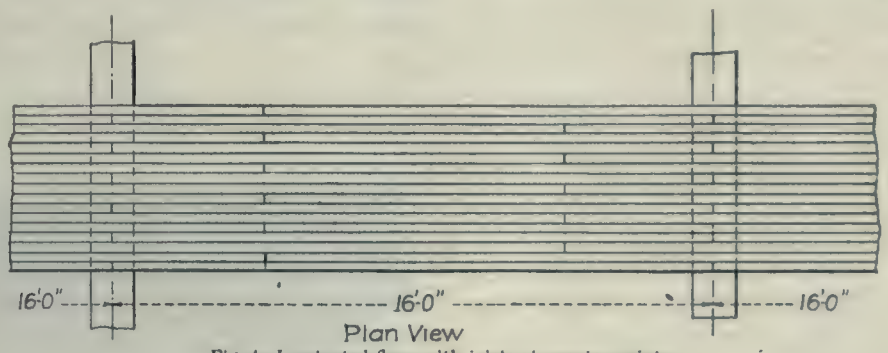


Fig. 4—Laminated floor with joists at quarter points.

The top floor may be of softwood or hardwood as use demands. Tongued and grooved flooring is used almost entirely. Square-edged flooring is easier to replace when repairs are needed, but wears less around nails, thus making an uneven floor. Some of the best buildings have a double top floor, the lower part of softwood, laid diagonally upon the plank under-floor and the hardwood upper part laid lengthwise. This latter method allows boards in alleys or passages to be easily replaced when worn, and the diagonal boards brace the floors, reduce vibration, and distribute the floor load evenly. The top floor should always be laid so that the length of the pieces is parallel to the direction of the traffic or trucking. Usually this is lengthwise of the building.

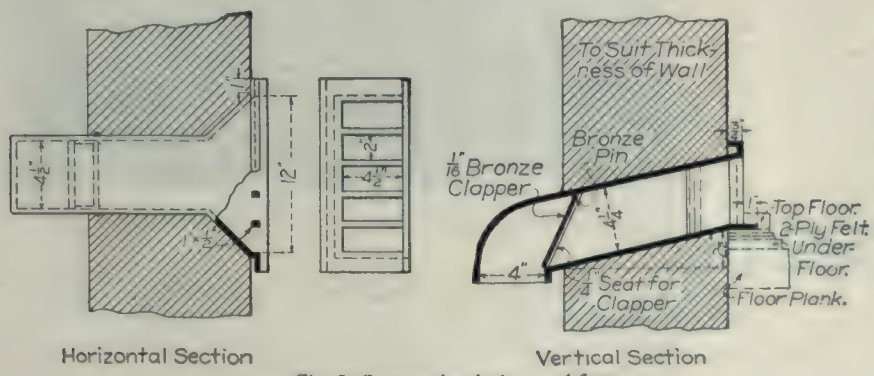


Fig. 5—Scupper for drainage of floors.

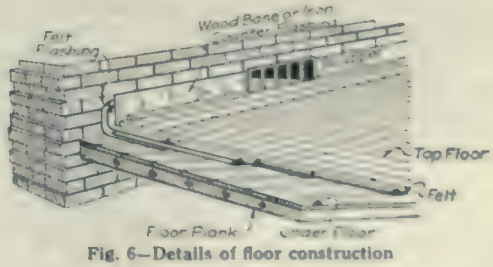


Fig. 6—Details of floor construction

If extra precaution is desired to prevent leakage of

water through floors, the various layers of waterproof paper should be laid to break joints and each joint mopped with hot tar or a similar protective material. Also floors may be given a pitch of 1 in. in 20 ft., and scuppers similar to that shown in Fig. 5 installed at floor level. These are ordinarily spaced from 20 to 40 feet apart along the wall.

The Associated Factory Mutual Fire Insurance Companies recommend the use of an approved elastic felt instead of waterproof paper. Their experience has been that felt properly laid gives better satisfaction in the long run. These companies recommend that a rough board floor be laid on top of the heavy plank floor, and that the waterproof felt be placed on this rough floor. A fairly smooth surface must be provided before the felt is laid, and any irregularity in the floor more than ⅛ in. deep should be filled up. Two layers of felt are used, breaking joints, and mopped with a sealing compound between the piles and on top of the felt. These companies recommend that the felt be turned up 6 in. at the posts and at the side walls. The hardwood top floor is laid in the hot compound closely following the final mopping, so that the nails holding it down are tightly gripped.

At the walls the felt is protected by a counterflashing of galvanized iron, or by a base-board nailed in place with the joints between it and the floor covered by a quarter-round. Both the base-board and quarter-round should be kept free from the top-floor, to allow the latter to move without breaking the corner of the turn-up in the felt. At the columns the felt may be protected by a base-board and quarter-round, as at the walls.

Fig. 6 gives details of floor construction and flashing at side walls, as described above, and as recommended by the Associated Factory Mutual Fire Insurance Companies.

The following extracts from the Building Code Recommended by the National Board of Fire Underwriters are of interest in connection with the general design of floor timbers and floors:

"Wooden girders or floor timbers shall be suitable for the load carried, but in no case less than 6 in. either dimension, and shall rest on iron plates on wall ledges and where entering walls shall be self-releasing. Walls may be corbeled out to support floor timbers where necessary. The corbeling shall not exceed 2 in.

"So far as possible, girders or floor timbers shall be single stick.

"Where wooden beams enter walls on opposite sides there shall be at least 12 in. of masonry between ends of beams, and in no case shall they enter more than one-quarter the thickness of the wall.

"Width of floor bays shall be between 6 and 11 ft.

"The practice in mill construction of supporting the ends of beams on girders by means of metal stirrups or bracket hangers is objectionable. Experience has shown that such metal supports are likely to lose their strength when attacked by fire and so cause collapse.

"Floors shall not be less than 3 in. (2¾ in. dressed) flooring laid crossways or diagonally. Top flooring shall not extend closer than ½ in. to walls, so as to allow for swelling in case floor becomes wet. This space shall be covered by a moulding, so arranged that it will not obstruct movement of the flooring.

"Waterproofing shall be laid between the planking and the floor in such manner as to make a thoroughly waterproof floor to a height of at least 3 in. above floor level. When there are no scuppers, the elevator or stairwells may be used as drains for the floors, in which case the waterproofing material need not be flashed up at these points.

"All exposed woodwork in exterior construction shall be planed smooth.

"Pipes or conduits extending through floors shall be fitted with metal thimbles and made watertight to a distance of 3 in. above floor.

"All floors shall be arranged to drain to elevator well or some other point where minimum damage will result from water. It is recommended that, where feasible, floors be built with a slight pitch (about 1 in. to 20 ft.), and have proper scuppers or drain pipes.

"Two thicknesses of waterproof paper, or its equivalent, to be laid between the planking and the flooring in such a manner as to make a thoroughly waterproof floor to a height of at least 3 in. above floor level. If the paper itself is waterproof, the joints should be swabbed with tar, pitch, or their equivalent, and overlapped at least 2 in. If the paper is not waterproof, the entire surface of the lower layer to be swabbed with tar, pitch, or their equivalent, and the upper layer placed on the lower while hot. Waterproofing paper to be flashed up at least 3 in. above floor openings and protected with mop board."

Fig. 7 shows an interesting point in connection with the erection of the framing in a mill construction building where laminated floors are used. This building was put up during cold weather, and the temperature was considered to be too low for laying brickwork properly. In order not to hinder the progress of the structure it was decided to go ahead with the framing of the floors and follow later with the walls. Supports similar to those shown at the end of the girder in Fig. 7 were used throughout each story of the building above the brickwork already placed. The posts were supported in place by braces at the cap to prevent them from falling sideways, and in the opposite direction by the girders themselves. The ends of the flooring at the walls were supported by a temporary plate, which could be easily removed after the final wall support was in place.

Fig. 7.—Framing and floors in place in advance of walls

Basement Floors.

Creosoted wood block floors for basements or for shop floors give excellent service and are easy for workmen to stand on. A floor of this type made of blocks well seasoned before treatment and laying, having the joints made with an approved cement or pitch filler, should last twenty years or more. Seasoning prevents shrinkage in the blocks after laying where used indoors. This is the opposite condition to that met in outdoor work. In the creosoting, an empty cell treating process, with five to eight pounds of oil per cubic foot, gives an excellent floor at moderate cost. When not subject to moisture or water soaking, etc.,

the blocks can be laid with close joints. Under moist conditions, a ⅛ in. joint closed with pitch is advisable. A good specification for a wood block floor is as follows:

In wet ground first spread a thoroughly compact layer of cinders or gravel about 6 to 12 in. deep as the sub-foundation. Then place a 4 in. layer of Portland cement concrete. A ½ in. layer of sand and cement grout is spread on top of the concrete and smoothed, preferably with a template, until level, to serve as a bed or cushion for the blocks.

Wood blocks may be used for upper floors if desired by placing under them two layers of paper laid in pitch, bedding the blocks in hot pitch and filling the joints with the same material.

A good basement or shop floor is made by laying a wood wearing surface on a base consisting of concrete and coal tar which contains from 20 to 25 per cent. of creosote oil. Such a floor is made by first spreading a 4 in. layer of screened gravel or stone not larger than 2½ inches, mixed with tar. The tar is heated to 200 degrees F., and enough used so that the mixture will be compact when rolled. The sand and gravel should be well heated before the tar is added. Often a 4 to 6 in. base of Portland cement concrete takes the place of the tar concrete. When cement concrete is used, it should be given a coat of tar before the top course is laid. A layer of tar and sand mixed in the proportion of 50 or 60 gallons of tar to each yard of sand and heated to 225 degrees F. is spread over the base to a depth of 1¼ in., and plank 3 in. thick is laid directly over this top coat while it is still warm and before it sets. The plank is then tamped into place, toe-nailed together, and a top or wearing floor laid on the plank.

If it is desired, an ordinary concrete floor may be used in basements. Such a floor has a base similar to that described for the block floor, covered with a layer of 1:2:4 Portland cement concrete 4 in. to 6 in. thick and finished with a wearing coat of cement and sand. This top coat is usually from 1 in. to 2 in. thick and composed of a 1:2 mixture of cement and sand. Top should be kept wet for at least ten days after laying.

(To be continued.)

The British Government Promotes Industrial and Scientific Research

REPORTING the activities of the first year of its work, and discussing in full detail in a 56-page pamphlet the plans and needs for future success, the advisory council of the British Committee for Scientific and Industrial Research is developing principles about which engineers in this country should be informed. In view of the efforts being made in Canada through the work of the newly appointed Advisory Council of Industrial and Scientific Research, the following abstract of the first annual report, by Engineering Record, has direct application to the problems which will face us when the war is over.

Object and Appropriations.

The advisory council to the Committee of the Privy Council for Scientific and Industrial Research, reporting to the British Parliament, was created July 28, 1915, "for (1) instituting specific researches; (2) establishing or developing special institutions or departments of existing institutions for the scientific study of problems affecting particular industries and trades; and (3) the establishment and award of research studentships and fellowships." Its chairman is Sir William S. McCormick.

In the first annual report of the committee, recently issued, it is stated that twenty scientific investigations of industrial importance have been approved and grants made to a number of individual research workers, not exceeding £6,000 (about $30,000) for the first year. The amount appropriated for the initiation of the scheme was £25,000, and for the current year £40,000 was voted.

Scope of Report of Advisory Council.

The first annual report of the advisory council discusses previous government action relating to the advancement of trade and industry by means of scientific research, the present government scheme, the details of the methods used, parallel movements, trade associations, impediments to industrial research, the need for a new outlook, American and German practice, the sphere of universities and technical schools and of special research institutes, research and government departments, and, finally, research and the empire.

The scope of the present work is further indicated by the statement that the government intends to deal with this problem as an integral part of a comprehensive improvement in the educational system.

Necessity for Central Control.

It is pointed out that while the necessity for central control of the machinery for war has been obvious for centuries, not until this war revealed the essential unity of the knowledge required for both the military and industrial efforts of a country was this vital fact understood. The instruments of war are now forged by the man of science. "This is equally true of the weapons of industry. The brains, even the very processes, that to-day are necessary to the output of munitions were yesterday needed, and will be needed again to-morrow, for the arts of peace. This is the central fact which justifies the establishment of the new machinery in the midst of a struggle that is absorbing the whole energies of the nation in a way no previous war has done."

Why Pure Science Must Be Neglected.

In view of the average manufacturer's requirement of quick returns, and as a present basis for a considered programme and policy, the council decided to give applied science precedence over pure science. The universities, which are the natural homes of research in pure science, have been so depleted of both students and teachers by the war that they are barely able to continue routine work, and cannot command either the leisure or the detachment which is an essential condition of original research. Enquiries show that "any effective encouragement of research in pure science must await the return of peace."

To save certain researches being conducted by professional associations which were in danger of enforced abandonment, the council recommended the payment

of a series of grants to the societies concerned. Many interviews have been had, not alone with the principal engineering society representatives, but with others from professional and manufacturers' associations. It is noted that the most highly organized industries are those which have made the most use of scientific research—especially the engineering trades, backed by distinguished professional societies.

Survey of Researches.

A careful survey is being made of "the amount and the character of the provision made in our higher educational institutions for research work," as a part of the preparatory arrangements for a systematic programme of aid to individual researchers. It is hoped, also, to induce industrial firms to inform the council, in confidence, of the problems they have in hand or in contemplation. "It is obvious that even this modest degree of co-ordination will be abortive unless the principal manufacturers are willing to trust the discretion of the council."

There are found indications or a change in view among certain firms, resulting from the necessities of the war, leading to interchange of information, which may survive the present critical days. "In the numerous conferences we have had with representatives of different industries we have been impressed with the spirit of co-operation which is growing up and the willingness to accept our suggestions for the initiation of research for the benefit of the trade as a whole. Co-operative research, when it has done its utmost, will always leave ample room for individual initiative and ability in the application of its results, more than sufficient as an incentive and as a means to outstanding success. Co-operation is not the negation of individual effort; it raises initiative to a higher power."

In spite of the grave effects of the war on the field of research in educational institutions, the council has recommended grants to some forty individuals. It is stated that "research in pure science should be as much our care as research in applied science; it is the necessary precedent of all industrial applications, and the universities are peculiarly fitted to pursue it, though for the reasons already explained it is not possible to do much in this direction during the war." The council hopes to bring more reality into academic laboratories now dominated by the text-book and the syllabus of examination, and "so encourage a better professional training for chemists, physicists, and other men of science."

Danger in Applied Researches.

On the other hand, the report says: "At the same time we recognize that there is a danger in bringing technical problems too pressingly to the notice of teachers and students in educational institutions. We must not tempt those capable of making advances in natural knowledge to abandon their austere studies for the sake of solving temporary and local technical problems. Still less must students be encouraged to take up such questions except as stimulating incidents in their general training. On the other hand, pure science has in the past owed much to observations, suggestions, and difficulties which have come from activities external to the laboratory or study. So it will be again; and it is our desire so to order the relations of workers in pure science to the industries going on around them that they may receive the stimulus of a wider outlook than is always attainable under the limitations of an academic system of syllabus and examination. In this way it may be possible in the end to create such an atmosphere that the new generation of students will cease to draw a distinction between 'theory' and 'practice,' and technologists of all ranks will, through them, attain to the view that sound practice is only theory tempered by compromise."

Applications for aid were received from the professional societies, and this led to the formation of a group of standing committees to assist in surveying the whole field of research and dealing with such applications. Three standing committees have been set up—a committee on metallurgy, a committee on engineering under Sir Maurice Fitzmaurice as chairman, and a committee on mining. Each committee consists of about fifteen members, of whom approximately one-half have been nominated by the professional society concerned.

Best Advice Sought.

"The council hope, with the assistance of their standing committees, the professional societies, the Home Office, and the Board of Trade, gradually to construct panels of names which will enable them to obtain the very best advice on the different aspects of the problems they are called upon to solve. The advice they need may be commercial, economic, financial, or scientific. The best opinion in all these spheres will, it is hoped, be available on the panels for the guidance of the council and their standing committees, and will insure the confidence of the industries concerned that the steps proposed have been considered in all their aspects."

Discussing the need for a new outlook, the council says: "If a healthy condition of enquiry is to be fostered in the scientific industries, they must for some time to come expend a good deal of attention and money upon convincing the manufacturing world in general that scientific research is a paying proposition. They believe that the shortest means to this end is an attack upon the pressing problems of manufacture which arise in the course of the ordinary routine—problems which the manufacturers ought, no doubt, to solve by means of their own scientific staffs, but which their present staffs are too small to undertake, often because the firms are too small to bear the necessary cost. It was in this way that the universities of the middle states of America convinced the farmers that science was useful to agriculture."

Conditions of Success.

In conclusion, the report refers to a full list of the researches aided up to the present, given in an appendix. The probable insufficiency of trained research workers after the war is emphasized, and, further, the need not so much for outstanding minds of exceptional power, but for systematized work of more ordinary investigators under competent direction. "There is as much place and need for plodding labor in scientific research as in other kinds of work." Greater progress in co-operative effort is given as the second condition of success, and the report says: "If the general level of manufacture can be rapidly raised by co-operative effort in the exchange of information between firms, and in the support of national trade institutes for research, as well as in the improvement of the conditions and efficiency of labor, this country will have gone far toward establishing its industrial prosperity on a firm basis."

The Montreal Board of Control will recommend the engagement of Mr. Bion J. Arnold, of Chicago, to advise the board in connection with the new franchise which is now being negotiated with the Tramways Company. The cost is not to exceed $10,000.

Specifications for Highway Bridges

Comprehensive Proposals Covering the Design of Steel Structures Carrying Highway Traffic With and Without Electric Street Cars.

THE proposed specifications for highway bridges were discussed at the meeting of the mechanical section of the Canadian Society of Civil Engineers, held in Montreal on November 30. Copies of the proposed specifications have been sent to the various branches for their observations and when these have been received, the committee will consider the criticisms and make final recommendations to the annual meeting of the members. The draft was read by Mr. P. B. Motley, chairman of the committee, and various points were dealt with by Messrs. G. H. Duggan, C. N. Monsarrat, W. C. Thomson, P. L. Pratley (designing engineer Dominion Bridge Co.), Walter J. Francis (who presided), H. B. Stuart (structural engineer, G. T. Railway), F. P. Shearwood, and Prof. Brown. The specifications are very comprehensive, and include bridges carrying electric railways and highway bridges. Mr. Shearwood dealt at length with the reasons why the committee had included certain requirements, stating that the object of the committee was to obtain a safe bridge at a reasonable cost. General practice had been followed unless there were some deviations which gave distinct advantages. Mr. Thomson and Prof. Brown made a number of suggestions as to amending the draft, while the chairman stated that the document should be used as specifications and was not meant to take the place of a consulting engineer. Mr. Motley replied that this was the purpose of the specifications.

Mr. Duggan, after a short review of the various kinds of bridges, said that Mr. Pratley had drawn up at his suggestion a paper embodying a number of suggestions, with the whole of which he (Mr. Duggan) did not agree. The following are the suggestions:

These specifications are intended to apply to steel highway bridges carrying ordinary highway traffic with or without electric street cars. They will not, however, cover bridges which carry electric railways only, as these will be designed under the specification for steel railway bridges.

In the case of combination bridges, carrying both railway and highway traffic, the responsible engineers on each individual project will be expected to issue particular specifications governing the questions of loading and unit stresses. Further, insomuch that modern practice has adopted riveted structures for all ordinary highway work, the specifications will not cover pin bridges, so that in the instance of long and important structures, where eye-bars and pin connections might possibly be used to advantage, special clauses covering this class of work will need to be drawn up by the responsible engineer.

The range of service to be accommodated under the general head of highway traffic is, necessarily, extremely wide, but the following are the principal considerations which will enter fundamentally into the design of those structures covered by this specification.

Firstly.—The amount of money available for the construction and its effect on the question of the permanency or semi-permanency of the bridge and upon the question of providing for probable future increase in traffic.

Secondly.—The location of the bridge and the character of the roads in its neighborhood with the probability of their being subject to improvement.

Thirdly.—The situation with respect to traffic as affecting the character of the flooring and the nature and magnitude of the superimposed loads.

With a view to meeting the whole range of conditions the specification classifies bridges according to the requirements of service and permanency under the following heads:

Class 1 is intended to provide for first-class permanent structures situated on main arteries of traffic in large towns and cities where heavy concentrated loads, due to transportation of machinery and building material frequently occur. Bridges as designed under this class, will be equal in respect to permanency, rigidity, thickness of metal, and all details, to those built under the best railway practice.

Class 2 is intended to provide for city bridges in residential districts, where general traffic regulations limit both the loads carried on the highway and the speed of street car traffic. Bridges designed under this class will be equal to those designed under Class 1 in respect of general stiffness and constructional details.

Class 3 is intended to provide for highway bridges in towns where heavy manufacturing is not conducted and for bridges on main country highways. The need of providing for actual or possible street car traffic and the issuing of specifications regarding the street car loads are matters which will be left to the responsible engineer.

Class 4 is intended to govern roadway bridges serving farming communities and situated on unpaved roads where it is unlikely that the character of the loading will change during the normal life of the structure.

Class 5 is intended to provide for bridges in remote or mountainous districts difficult of access, where lightness and first cost are prime considerations in determining the character of the proposed bridge.

The purpose of the classification is not to rigidly group every bridge under a specific head, but to guide the responsible engineer or purchasing authority in the making of suitable decisions regarding loads, unit stresses and general design; in consequence whereof the clauses touching upon these essential questions will refer to the various classes suggested. The engineer on important bridges will still be expected to use his professional judgment and his knowledge of local conditions, either of which may justifiably lead him to a combination or modification of the classes above outlined or of the clauses in the specification referring thereto.

Movable Bridges

The specifications cover the design of the structural work for all kinds of movable spans, and include clauses governing the design of the machinery and machined parts of hand operated swing bridges. In the case of power operated swing spans, bascule or vertical lift bridges, where the machinery is an all-

important feature of the construction, it is recommended that the design of these features be referred to an engineer specializing in this work.

FLOORS

For bridges built under classes 1 and 2 a careful description of the floor system to be employed should be supplied by the responsible engineer, preferably by drawing or detail sketch. Special care should be taken to indicate the proposed method of carrying street car tracks.

A "permanent" floor shall be understood to signify a floor where the base consists of either—

(a) Reinforced concrete slabs;

(b) Concrete or brick jack arches;

(c) Buckle or trough plates carrying the concrete matte.

A floor where the base is wood, whether creosoted or not, will not be considered permanent.

Under Class 1 a permanent type of floor is everywhere demanded and the pavement or upper course shall be of granite setts, brick, asphalt, macadam, or treated wood blocks as determined by the engineer.

Under Classes 2 and 3 the character of the floor will be specified directly by the responsible engineer, but it is stipulated that the stringers shall be of steel and the structure shall be designed to carry at the specified unit stresses a floor consisting of a reinforced concrete base with a pavement of 4-inch wood blocks or any other heavier type which may subsequently be laid.

Under Class 4 a wooden floor is permitted, but the adoption of steel stringers is recommended.

Under Class 5 the lightest type of wooden floor is allowed, but even here an enquiry into the probable ultimate economy of longer panels with steel stringers is suggested.

Sidewalks

Under Class 1 sidewalks shall also be permanent, and shall have a cement finish to the slab or a special wearing surface of asphalt or granolithic paving. For the remaining classes sidewalks may be of wood at the discretion of the responsible engineer.

Wooden Floors

Wooden stringers shall not be used on greater spans than 15 feet and shall have a width of not less than 3 inches or one-fourth of their depth. They shall lap by each other on the floor beams to give each a full bearing and shall be bolted together, using washer separators not less than one-half inch thick in order to secure free circulation of air.

Wheel Guards

On wooden floors wheel guards, of 6 x 4 timber, shall be provided at each side of the roadway and shall be supported on 2-inch blocks spaced not over 5 feet, held in place by a three-quarter inch bolt through the guard, the blocking piece and the timber floor. The splices in wheel guards shall be half lap joints 6 inches long, and shall occur over the blocking pieces.

For permanent floors the wheel guard will, generally, be formed of concrete effectively protected by steel angle rubbing pieces.

Scuppers

On permanent floors of any description suitable scuppers shall be provided not less than 20 feet apart, so arranged to carry all drainage clear of steelwork.

LIVE LOADS

The varied character of the loads applied to highway bridges renders it impossible to include in a general specification a statement of the precise loading to be used on every bridge and any table of suggested typical loads must be recognized as necessarily having the following limited purposes:

(a) To guide the responsible engineer in his choice of a structure in regard to capacity and efficiency.

(b) To indicate to non-technical officials or to engineers not specially experienced in bridge-work, what constitutes accepted good practice.

(c) To guard against the possibility of a structure being provided, which is insufficient to meet the immediate requirements or those reasonably certain to occur in the future.

On the other hand, the specifications should not prevent the building of very light bridges, which, while sufficiently strong to withstand the vertical and vibratory loadings, should be able to compete successfully in the matter of first cost and maintenance with the alternative wooden construction. The majority of existing light structures, which would fall under the 5th class, above indicated, have not been built to any of the recognized standard specifications, and, indeed, no present specifications in vogue in Canada permit of this, nevertheless necessary, class of bridge. With the idea of meeting both the financial and service requirements of such cases, the permissible loadings under class 5, as well as certain other limitations, are less exacting than in the existing standard specifications.

Two Main Divisions

The loading on a highway bridge, naturally, falls under two main divisions, the assumed uniformly distributed load and concentrated wheel loads. The first division will consist, generally, of crowds of people, animals in droves or a large number of light vehicles. Crowds of people, such as quickly gather at accidents or for sight-seeing, on city bridges, are seldom productive of 100 lb. sq. ft. average load, and for moving loads this figure would, undoubtedly, cover all cases to be provided for at ordinary unit stresses. Classes 1 and 2 are likely to experience such loads at frequent intervals and for almost unlimited lengths, while classes 3 and 4 may receive the same intensity of loading but far less often, and over smaller areas. Animals in droves will never exceed 60 lbs. per sq. ft. and for class 5 this would represent the maximum load.

The second division will include all classes of heavy vehicles such as street cars, auto trucks, horse-drawn lorries and road-making machinery. Local conditions alone can determine the type and magnitude of loading for which steel should be proportioned.

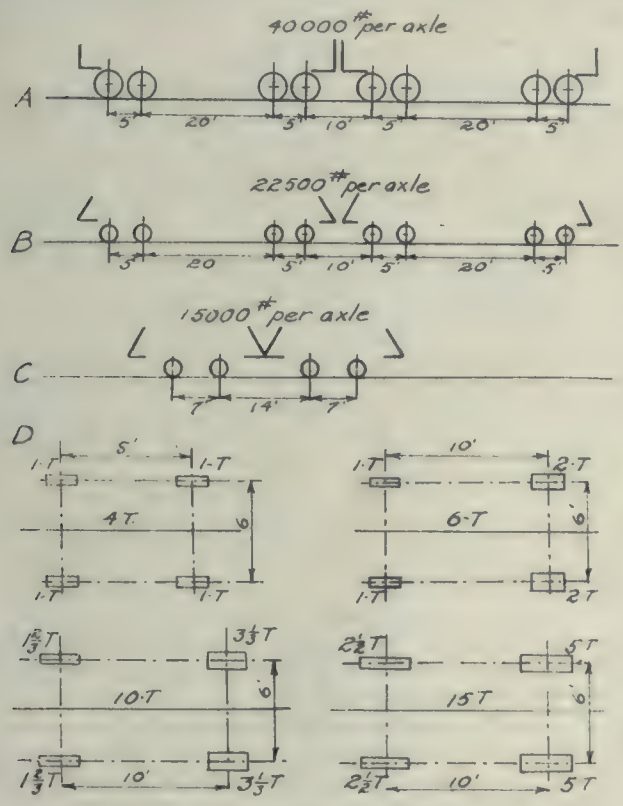
In bridges of classes 1 and 2 the proximity of factories, wharves, railway yards, the nature of the street car service, the possibility of loads, due to building materials, cable spools, heavy guns, steam rollers, or traction engines must all be duly considered in specifying the applied concentrations. It may also be noted here that the authorities owning these classes of bridges are also generally empowered to regulate traffic, and it will devolve upon their executive engineer to consider the principle of equity involved in the question, whether the publicly owned bridge should be capable of accommodating some unusual "freak" load, avoidable at a certain cost to the transportation com-

pany, or whether the traffic regulations should not control the use of the bridge for such purposes on the basis of engineering economics.

The figures given in the following tables are considered safe maximums for usual cases, and are recommended for adoption only in default of specific information from the responsible engineer.

Impact

The function of the so-called impact allowance is twofold. Firstly, to take care of actual increases in the magnitude of the applied load liable to occur at infrequent intervals. Secondly, to make provision for the increased stresses due to dynamic application of the loads. To the uniformly distributed loads described above only the first aspect of impact will apply, and in so much as same maximum figures are recommended for adoption no further increment for use at



Diagrams of wheel loads applying to steel highway bridges.

normal unit stresses is considered necessary. To concentrated wheel loads both aspects of impact may be presumed to apply, and a simple percentage of the static load is suggested as the increment. It is be lieved that the effects of the dead load and the length of the span affected are suitably provided for in this percentage, in so much as the concentrated loads will in general govern floor members only, and the type and weight of floor will bear some sensible relation to the magnitude and ferocity of the wheel loads.

Table of Live Loads

1. For floor stringers, cross beams, hangers, and any members of trusses and girders where concentrated wheel loads govern the sections.

	Uniform Load	Street Cars	Trucks, etc. See Dia. D
Class 1	100 lbs. per sq. ft.	Diagram A	2-15 ton alongside or following
Class 2	100 lbs. per sq. ft.	Diagram B	1-15 Ton
Class 3	100 lbs. per sq. ft.	Diagram B or C (if any)	1-10 Ton
Class 4	80 lbs. per sq. ft.	None	1-6 Ton
Class 5	60 lbs. per sq. ft.	None	1-4 Ton.

2. For trusses and girders.

	Uniform Load	Street Cars
Class 1.	100 lbs. per sq. ft. up to 200 ft., thence diminishing arithmetically to a minimum of 75 lbs. at 400 ft.	2400 lbs. per ft. per track for freight cars. 2000 lbs. per ft. per track for passenger cars.
Class 2.	100 lbs. per sq. ft. up to 100 ft., thence diminishing arithmetically to a minimum of 60 lbs. at 300 feet.	2000 lbs. per foot per track.
Class 3.	80 lbs. per sq. ft. up to 100 ft., thence diminishing arithmetically to a minimum of 50 lbs. at 200 feet.	1600 lbs. per foot per track if any.
Class 4.	80 lbs. per sq. ft. up to 80 ft., thence diminishing arithmetically to a minimum of 50 lbs. at 200 feet.	None
Class 5.	60 lbs. per sq. ft. up to 60 ft., thence diminishing arithmetically to a minimum of 40 lbs. at 100 feet.	None

1 **Scope and Combination of Loads**

Uniform live load shall be applied to full width of road surface between wheel guards and on sidewalks to the maximum clear width available for traffic. The assumed equivalent uniform live load for street cars shall be applicable to the whole length of the trackage on the span or any portion thereof. Each street car track shall be assumed to occupy 10 feet width of roadway. The following combinations shall be considered possible:—

Street car loads and other concentrated or uniform loads for floor beams and hangers.

Street car loads and half uniform load on remainder of floor surface for trusses of Classes 1, 2 and 3.

When sidewalks are carried on brackets outside of the main trusses provision shall be made in the trusses for the cantilever effect of loading one sidewalk and the full road surface between trusses with 75 per cent. of the specified uniform loading.

Impact

The percentages of the live load from wheel concentrations to be added for impact will be as follows:

To stringers forty per cent.

To floor beams and hangers and other truss members affected 20 per cent.

The electrical industry of Montreal, in practically all branches, is very busy at the present time. The building and operation of munitions plants have a strong influence on the industry—for instance, there has been a very good demand for motors and accessories, and at one period it was exceedingly difficult to obtain immediate deliveries. The munitions and industrial plants are large consumers of current, and the business of the power companies shows a marked expansion. With regard to electrical supplies, the difficulty of manufacturers is in some instances to obtain an adequate supply of raw materials, while prices for the various materials have advanced to very high figures.

Report on Roads of Wellington County, Ontario

The report of County Road Superintendent J. M. Young was read at a recent session of the council of Wellington County, Ont., and was referred to the County Roads Committee. Owing to road repairs coming under the Highway Improvement Act this year, it was stated that the system of carrying out the work had to be somewhat changed. Difficulties also arose on account of the scarcity of suitable labor and the almost impassable condition of the roads in the spring, due to the very severe winter frost and the extremely wet weather in the early part of the season. Though these circumstances prevented the work being carried out in some cases as satisfactorily as it might have been, the superintendent and the several commissioners by united effort succeeded in bringing the roads to a much better state of repair than was expected. Several sections of stone road which had become rough had been reinforced with Tarvia A. and B. and appeared to be doing very well, but the superintendent preferred to wait until next summer before making a recommendation as to its value. Road-oil was used on several sections of road and in every case gave satisfaction. Mr. Young believed it should be used on all roads which had been well constructed, as it would be the cheapest system of maintenance. He recommended that the question of purchasing road oil be taken up early in the session and that some system of storing it be devised so that it might be purchased at the lowest possible price. A number of bridges were constructed or are in course of construction. Owing to the scarcity of steel and iron, several had not been completed, and the superintendent stated that some of the bridges whose completion had been delayed till late in the season would not have as good a finish as if they had been completed earlier. A list of all bridges of 10-foot span and over was included in the report. These were as follows:—

Brown's bridge, county road No. 41. Arthur Township, 35 ft. span, reinforced concrete truss, railings. Not completed.

Stirton bridge, county road No. 36, Peel Township, 35 ft. span, reinforced concrete truss. Almost completed.

Flax Mill bridge, county road No. 37, Maryborough Township, 70 ft. span, reinforced concrete truss. Not completed.

McKee's bridge, county road No. 12, Peel Township, 24 ft. reinforced concrete beam span with breakwater. Fully completed.

Campbell's bridge, county road No. 32, Peel Township, beam span reinforced concrete. Completed.

McCarron's bridge, county road No. 32, Peel Township, 14 ft. span, reinforced concrete slab. Completed.

Gregson bridge, county road No. 23, Erin Township, reinforced concrete slab. Completed.

Prison Farm bridge, county road No. 4, Guelph Township, 10 ft. span, reinforced concrete slab. Completed.

Howe bridge No. 1, county road No. 5, Pilkington Township, 14 ft. reinforced concrete slab. Completed.

Howe bridge No. 2, county road No. 5, Pilkington Township, 30 foot reinforced concrete truss. Abutments only built.

Gibson bridge, county road No. 29, West Garafraxa, 63 foot span, reinforced concrete. Abutments only built.

Several culverts under ten-foot span were also erected during the season and a large number of pipe culverts placed, where necessary. With regard to material for repairing roads, it was recommended that the teaming be done in the winter and the material placed in piles as close as possible to where the repairs would probably be needed. The labor problem in the summer season appeared to be getting more difficult to solve each year.

The report of the treasurer showed that up till the end of November the county had expended $50,173.55 on roads during the year. Of this amount, $41,302.33 was for county roads, $2,537.43 for townships and villages off county roads, $1,685.61 for road machinery, and $4,648.18 for miscellaneous roads.

Split Log Drag Competition in Manitoba

At a recent meeting of the executive committee of the Manitoba Good Roads Association the judges' report on the 1916 annual split log drag competition was made public. The awards were as follows:

Gravel Class.

1. $50 and Banfield Cup—Second mile of the east main road from R. Lot 110 to R. Lot 94, in Ward 1, Municipality of East St. Paul.

2. $30—First mile of east main road from Kildonan boundary as far as R. Lot 110, Municipality of East St. Paul.

3 $20—One mile on Warren Road through 25-13-1E, Municipality of Rockwood.

3. Special prize, the T. Eaton watch—One mile east of 13-14-1E., Municipality of Rockwood.

4. $10—One mile between 16-21-13-2E., Municipality of Rockwood.

4. Special prize, $10—One mile north from the Kildonan boundary on the two-mile road (Panet Road), Municipality of East St. Paul.

Special prize—Cuff links presented by Messrs. Henry Birks & Sons—Two-mile road, one mile south from the Hoddinott Road or Village of Bird's Hill, Municipality of East St. Paul.

Earth Class.

1. $50 and the Henry Birks & Sons shield—Two miles between 4 and 5-11-5E. and 32 and 33-10-5E., Municipality of Springfield.

2. $30—Two miles extending westward from the C.N.R. station at St. Agathe, between R.R. Lots 559 and 651 to southwest corner Section 23-7-2E., Municipality of Macdonald.

3. $20—Two miles north of 22 and 23-16-2E., Municipality of Rockwood.

4. $10—Two miles north of 10 and 11-16-2E., Munipality of Rockwood.

The report states that there were many very fine pieces of gravel roads in the competition, all of them, generally speaking, in good condition. The judges state that "the extension of the dragging season is, in the opinion of your judges, an excellent improvement on the method of only dragging for two or three months during the year, and we are firmly convinced that the only way to maintain an earth road is to drag it at the proper time and until the freeze-up. The benefit to roads that have been thus dragged will be marked, especially in the spring, after the snow goes, and we would strongly recommend that this practice be adhered to in future competitions."

The report urges that some plan be inaugurated whereby more municipalities would be induced to maintain their leading roads by a system of dragging throughout the season, and municipalities are urged to take advantage of the government's offer to send out an organizer and instructor for the purpose of main-

taining their roads in a more uniform manner. It was also suggested that this matter be again brought to the attention of all municipalities in the province in the form of a campaign for better road maintenance. The town of Stonewall and the municipality of Rockwood were mentioned as especially deserving of commendation for placing large mileages in the competition. The judges were Messrs. S. R. Henderson, W. F. Tallman, A. McGillivray, and A. C. Emmett.

The Problems of Street Congestion and Motor Vehicle Traffic

By N. P. Lewis*

Among the most difficult problems presented to road planners is that of street traffic. The increase in the volume of this traffic has been almost sensational during recent years, especially since the use of the motor vehicle became general. While this increase is quite obvious in all cities, the statistics in street traffic in London are unusually complete, and the reports of the London traffic branch of the Board of Trade bring out some remarkable facts. The number of horse-drawn cabs licensed by the Metropolitan Police decreased from 11,404 in 1903 to 2,385 in 1912, while during the same period the number of motor cabs increased from 1 to 7,969. During the same period the motor omnibuses increased from 13 to 2,908, while the 3,623 horse-drawn omnibuses in 1903 have entirely disappeared. Some remarkable statistics are given as to the number of vehicles passing certain points at certain hours and during the day, but the surprising feature of these statistics is that the total number of vehicles licensed in 1912, including tramway cars, was actually 203 less than in 1903. No better illustration is afforded of the enormous increase in the service rendered by motor vehicles owing to their higher speed and greater flexibility.

On certain streets of all busy cities the number of vehicles is so great and the resulting congestion is so serious that students of this problem have become much alarmed, and are discussing the need of more effective traffic regulation. The easiest solution of this problem appears, however, to be the better diffusion or distribution of traffic, and this can in no way be more effectively brought about than by a better and more uniform standard of improvement of the roadways of both urban and rural highways.

Why is it that so many drivers of vehicles tend to use the same street when many different possible routes could be followed? Undoubtedly the chief reason is that they wish to use the streets that are best paved. In the case of the motor vehicle a slight detour, with corresponding increase of distance, is of little consequence, and time will actually be saved by the avoidance of traffic congestion, but those who are riding, especially for pleasure, prefer to follow the streets that are most attractive—those on which the abutting property has been improved to a higher degree and in a little more sightly manner. When our streets shall have become uniformly well paved and when the property along them shall have been improved according to better standards—not necessarily with palatial homes, but with good taste—when tree-planting is taken up more seriously, and when the space not needed for roadways and footpaths is devoted to grass plots or planted with shrubbery, those with whom time is not the important element will follow these streets, now given over wholly to the delivery wagons of the milkman, the grocer, and the butcher, and appreciable progress will have been made in the solution of the traffic problem. There is, however, a very serious problem which has grown out of the use of motor vehicles, namely, the increasing weight, the increasing wheel loads, and the increasing size of these vehicles. The motor or the tractor can overcome grades with heavy loads which were impossible to the horse-drawn vehicle, and highway officials responsible for the maintenance of our city streets and of the country highways leading out of them are greatly concerned at the damage inflicted upon road surfaces by these loads. The only effective remedy appears to be the enactment of drastic ordinances and laws which will absolutely prohibit the use of vehicles having more than a specified load per inch width of tire, and that load should probably be less for steel tires than for rubber tires.

The width and length of such vehicles is a matter of serious concern, especially on city streets. Where roadways have been designed to accommodate a certain number of lines of traffic and the number of lines is reduced through an increase in the width of the vehicles, the capacity of the roadway is reduced in still greater proportion, and, if this increase in width is allowed to proceed, very costly street widenings will become necessary. In this case, also, it would appear to be necessary to prohibit absolutely the use on our highways of vehicles having more than a certain specified width. The State Legislature of Pennsylvania in 1913 passed a law prohibiting the registration of motor vehicles exceeding 90 inches in width of loads and vehicle combined, except that motor buses for carrying passengers may be used within the limits of cities of the first, second, and third classes having a total width of 100 inches. The law also prohibits loads in excess of 24,000 pounds for vehicle and load combined or in excess of 18,000 pounds gross load on any axle, or 750 pounds for each nominal inch width of solid tire.

Fortunately, the tendency of the manufacturers of motor trucks appears to be in the direction of more moderate loads. Of 221 manufacturers producing commercial vehicles at the beginning of the present year 133 confined themselves to those of less than three tons capacity. Of the 88 manufacturers offering trucks of more than three tons capacity 12 appear to have increased this capacity in their models for this year, only two of these increases being the six tons, while six have decreased the capacity of their trucks, one from four to three and one-half tons, three from five to three and one-half tons, one from six to four tons, and one from seven and one-half to five tons. Of 12 newcomers in the field only one offers a truck with a capacity of six tons and two of five tons, while the rest provide for smaller loads.

While the imposition of an absolute limit upon wheel loads and upon the dimensions of vehicles seems necessary to preserve our highways, both in the city and country, the development of the motor vehicle appears on the whole to present no problems to highway officials, especially problems relating to street congestion, which will not solve themselves with the more general improvement of our streets and roadways and with the adoption of a higher standard of real estate development, which will make the subsidiary highways more attractive to those using motor vehicles.

* Chief engineer of the Board of Estimate and Apportionment, New York City, at annual dinner of American Road Builders' Association.

The Burlington Steel Company, Hamilton, have been awarded the contract for reinforcing steel for the Canadian Government elevator at St. John, N.B., contract for the erection of which has been let to the Fegles-Bellows Eng. Company.

Reinforced Concrete Building Design

Recommended Specifications for Structures to be Erected in Cities Not Having a Building Ordinance

The following specifications are recommended by the Portland Cement Association, Chicago, for use in designing buildings of reinforced concrete to be erected in cities not having a building ordinance.

If alternative designs are to be submitted, these specifications should accompany the architects' plans and details, and be headed by the following clause:

> "This building has been designed in accordance with the following specifications. Intending bidders wishing to submit alternative designs must follow strictly the design specifications and deposit $..... with bid to cover cost of checking said alternative design, which checking will be done by ..... of ..... The deposit of unsuccessful bidders will be returned when the contract is awarded."

Loads

The schedule of superimposed uniform (live) loads per square foot is as follows:

Roof ..... pounds per square foot.
.....floor.....pounds per square foot.
.....floor.....pounds per square foot.
Etc.

The roof slab, together with the roof beams and girders, shall be designed to carry the full live and dead loads. All floor slabs and beams shall be designed to carry the full live and dead loads. All girders under floors where the assumed live load is under 120 pounds per square foot shall be designed to carry all the dead load and 85 per cent. of the assumed live load. No deductions for floor loads greater than 120 pounds per square foot.

Every column, post or other vertical support shall be of sufficient strength to bear safely the combined live and dead loads transmitted to it.

The following reductions are permissible when the live loads are under 120 pounds per square foot:

For columns supporting roof: No reduction.

For columns supporting top floor: A reduction of 10 per cent. of the live load of the top floor may be made.

For columns supporting each succeeding floor: A reduction of 5 per cent. of the live load per floor may be made, but the maximum deduction for any floor shall not exceed 50 per cent. The reductions shall cease when a floor carrying a live load of more than 120 pounds per square foot is reached.

For floors, beams, girders and vertical supports carrying machinery: At least 25 per cent. shall be added to the stresses from live loads to provide for effect of impact and vibration.

For sidewalks between the curb and building lines: Live loads shall be taken at 300 pounds per square foot or a concentrated load of 5 tons at any point.

Materials

Cement: The cement shall meet the requirements of the current Standard Specifications for Portland Cement of the American Society for Testing Materials.

Steel: The steel shall meet the requirements of the current Standard Specifications for Reinforcing Steel of the American Society for Testing Materials.

Aggregates and Water: The aggregates and water shall meet the requirements of the current specifications for aggregates and water of the Portland Cement Association.

Broken stone or pebble concrete not reinforced shall be assumed as weighing 144 pounds per cubic foot, and when reinforced shall be assumed as weighing 150 pounds per cubic foot.

Stresses

Extreme fiber stress in compression for 1:2:4 concrete, 650 pounds per square inch. For 1:1½:3 concrete, 810 pounds per square inch.

In direct compression, 1:2:4 concrete, 450 pounds per square inch. 1:1½:3 concrete, 560 pounds per square inch.

Shearing stress in concrete when diagonal tension is not resisted by steel, 40 pounds per square inch for 1:2:4 concrete and 50 pounds for 1:1½:3 concrete.

Unit shearing stress when web reinforcement is used, 120 pounds per square inch, of which 40 pounds per square inch may be resisted by the concrete.

In proportioning the section of concrete for shearing stress, the effective depth from centre of compression area to centre of steel area shall be used. In beams of T section the width of the stem shall be used. In ribbed floors the width of the stem and thickness of flange near supports shall be proportioned for cumulative shear on the span.

Bond stress between concrete and reinforcement, 80 pounds per square inch for plain and deformed bars, based on actual section.

Tensile stress in steel, 16,000 pounds per square inch, for main reinforcement. Tensile stress in stirrup steel, 10,000 pounds per square inch.

Ratio of deformation of steel to 1:2:4 concrete shall be taken at 1:15 and to 1:1½:3 concrete shall be taken as 1:12.

Compressive stress in steel shall be equal to the compressive stress in the concrete multiplied by the ratio of deformation.

In continuous beams and slabs the extreme fiber stress in concrete in compression may be increased 15 per cent. adjacent to supports.

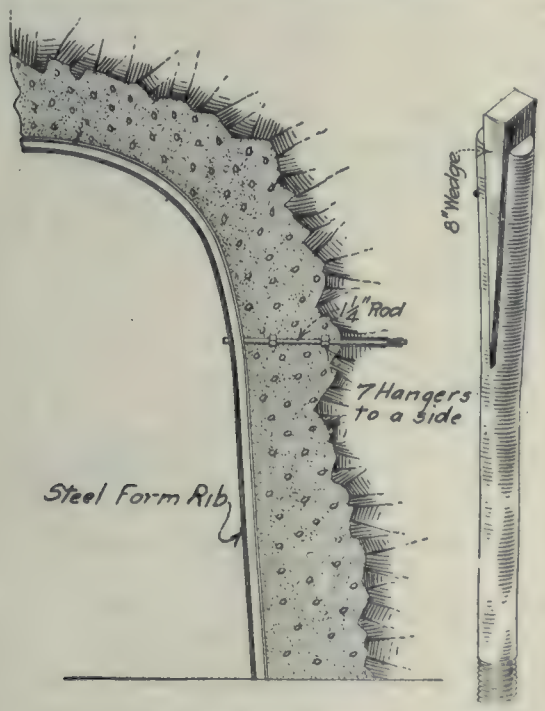
Bearing on a concrete surface having a total area of at least twice the area of the loaded portion may be taken at 700 pounds per square inch for 1:2:4 concrete and 875 pounds per square inch for 1:1½:3 concrete, and, generally, at 35 per cent. of the ultimate strength of the concrete used, when all other stresses are properly provided for.

(To be continued)

Railway Tunnel Lined by Pneumatic Methods

PNEUMATIC methods of placing concrete are being successfully made use of in lining the Sandy Ridge tunnel on the Carolina, Clinchfield and Ohio Railway. This work is characterized by the application of a specially designed self-contained concreting car, which is the main element of the equipment, and forms a portable mixing and placing plant. The Sandy Ridge tunnel is very nearly 1½ miles long and its width is 19 feet. It was opened for traffic in 1915, and the work of lining is being carried out under traffic.

The main part of the equipment is the concreting car, self-propelled by a gasoline engine, and fitted with a pneumatic mixer and bins for materials. The air for placing the concrete is supplied by a compressed air plant outside the tunnel and delivered through pipe line in the tunnel with taps at regularly-spaced intervals, so that the mixer on the car may be attached. The car operates on the regular railway tracks. It measures 40 feet long over all, 10 feet 4½ inches wide



Method of holding steel forms in place to permit tunnel to be lined.

and 17 feet 9 inches from top of rail to top of car. The mixer is located on one side of a central chamber extending the width of the car and open on the sides, which measures 8½ feet long and 10 feet 3 inches high. A charging skip is located on the other side of this space and over the chamber is a water tank of 1,850 gallons capacity, which supplies water for the concrete and also for cooling the gasoline engine. The storage bins for stone and sand are placed at the ends of the car and face the central chamber. A chute from each bin, controlled by a gate, leads to the charging skip. Cement is stored under the stone bin and the gasoline engine and driving equipment is housed beneath the sand bin.

Sand and stone are chuted to the charging skip, which is raised on inclined guide rails by compressed air to a position above the mixer, where it automatically dumps. An 8-inch outlet pipe conveys the concrete to the forms. The end of this pipe is branched, one line being arranged to shoot the concrete into the arch, and the other being bent to direct the material to the foundation and sidewall.

Five men are required to operate the equipment. One man controls the charging skip, supply of water, mixing and discharge of the batch. One man operates each chute and two men carry and empty the cement bags.

Loading and Storage Trestle

To keep the car supplied, a timber trestle is built outside the tunnel under which the car runs, receiving stone, sand, cement and water by gravity. Undercut gates allow the sand and stone to be drawn from overhead bins. Cement in bags is chuted into the car. There are 27 bins with a capacity of 324 cubic yards of aggregate, while above the deck of the trestle a track enables the storage of five loaded hopper cars giving an extra storage of 300 cubic yards.

Collapsible steel forms are employed except for the arch ring, where wooden forms on steel ribs are used. The sketch shows the manner in which the forms are held to the rock wall. A rod about 20 ins. long split at one end and threaded at the other, with the point of a wedge just entering the split, is inserted in a hole drilled in the rock. The rod is driven hard, causing the wedge to spread the split and hold fast. A square coupling is screwed in the tapped end of the rod and a second rod screwed into the outer end of the coupling. A third section is similarly fastened to the rod and holds the form in place. The square shape of the couplings prevents their turning when the outer rod is unscrewed.

The forms occur in sections of 30 feet, and when a section is prepared, one end is caused to overlap the concrete last placed and a bulkhead of sand bags is constructed at the open end, which is built up as the concrete rises. An entire section of concrete is not placed at once owing to the pressure of the wet material, but the walls are constructed to the spring-line at one operation.

Colored Concrete

For the production of colored effects in concrete work the following proportions for a finishing coat are given by the National Builder:

Gray—Carbon black, ½ lb. to one bag of cement.
Brown—Iron oxide, 6¼ lbs. to one bag of cement.
Red—Iron oxide, 7½ lbs. to one bag of cement.
Bright Red—Pompeian red, 6¼ lbs. to one bag of cement.
Buff or Yellow—Yellow ochre, 12½—17½ lbs. to one bag of cement.

The coloring material should be mixed dry with the cement, and all these ingredients, including water, must be measured exactly and mixed carefully, as the color always changes to some extent.

By mixing five pounds of coloring matter with each bag of cement in 1:2 mortar the following colors will result:

Brown—Roasted iron oxide.
Buff or Yellow—Yellow ochre.
Blue—Ultramarine.
Gray to Dark Slate—Lampblack or carbon black.

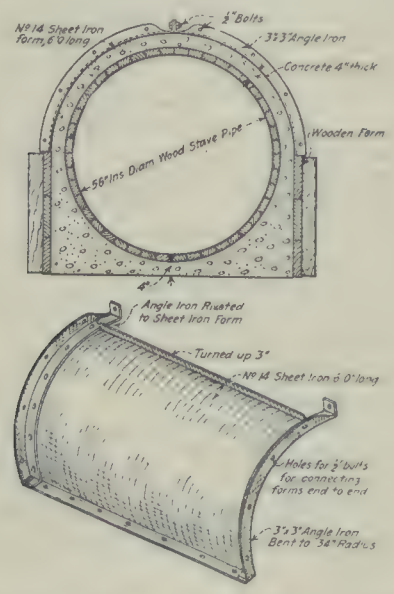
The Grand Trunk Railway Company will erect at their new shops at Port Huron which are to replace those destroyed by fire some time ago, a power house containing six 150 h.p. boilers, serving double steam turbo-generating units of 300 kw. for developing electric power for lighting and operation of machines, all of which will be motor driven.

Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

Casing Wood Stave Pipe to Prevent Decay

Wood stave pipe, extensively used for carrying water, is being more and more commonly cased with concrete to eliminate decay. This practice is most common for large size pipe. As the pipe is ordinarily buried, the most economical method of uncovering and



Casing a wood pipe with concrete when it is buried and full of water.

concreting warrants consideration. The plan of one contractor was as follows:

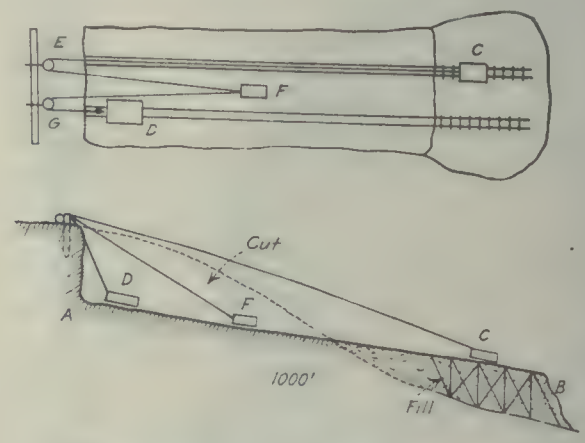
All the earth covering was first removed halfway down the pipe. Then at intervals of 15 feet strips of earth 3 or 4 feet wide were excavated under the pipe and the space filled with concrete, using the wood forms illustrated. After these preliminary concrete saddles had hardened, the earth between them was excavated and the space concreted as before. This method prevented any settlement of the pipe, which was running full of water.

The final operation was to cover with concrete the tops of the pipe, using the sheet steel form illustrated. About 4½ miles of pipe were cased as described. The contract price, exclusive of cement, was $4.56 per lineal foot.—Contractors' Review.

Haulage Outfit for Cutting Down a Hill

A contractor's haulage system for building a cut and fill incline is shown by the accompanying sketch, reproduced in the first issue of the new United States magazine, Contractors' Review. Such a construction condition arises in street and road work where a hill has to be cut down. For example, on most road construction along existing routes, grading is simply a task of smoothing to profile by scrapers and graders; deep cutting and filling is rare. Usually there is somewhere on the route a hill to be cut down and a valley filled, involving cut and embankments from a few hundred to perhaps a thousand feet long. These rare pieces of heavy grading do not warrant a steam shovel and car outfit, but, on the other hand, they are pretty heavy for a scraper outfit. The system illustrated is designed for these isolated heavy grading jobs.

In the sketch the dotted line indicates the original surface and the lines A B the new grades composed of cut and fill. Two lines of light truck are lined as shown, and two cars, C D, are employed. From car C a rope extends to sheave E, thence to brake drum F, thence to sheave G, and then to car D. When car D is loaded the brake F is released and the loaded car descends the grade and pulls the empty car C up to the



Method of removing a hill and filling an embankment by trucks and hauling line.

cut piece in position for loading. The truck and hauling line are extended as the work proceeds. For cut and fill up to 1,000 feet this arrangement is highly satisfactory.

Garbage Disposal Proves Profitable

THE question of garbage disposal is one, no doubt, which a great many municipalities have difficulty in solving. There is the necessity in the first place of selecting a suitable locality in order to facilitate the collection of the garbage and prevent too great expense through having to convey it long distances in the dump carts, and in the second place there must be no inconvenience or discomfort to residents in the neighborhood on account of unpleasant odours. The results of experiments which have been carried on in the city of Pontiac, Mich., show that not only have these difficulties been largely overcome, but the disposal plant is being operated on a profit-yielding basis.

The system used in the Pontiac garbage-disposal plant is such that there are no objectional odours noticeable outside of the plant, and even in the interior the odour is by no means strong or offensive. This desirable result is obtained by the use of steel tanks

in which the garbage is digested under a pressure of 70 pounds of steam and a vacuum pump which draws off the offensive odours continuously during the process, the gases being condensed and discharged into a sewer. A solution of nitrocene is also injected into the gases before their discharge, to insure their proper disposal.

The recovery of by-products is an important factor in the garbage disposal problem which municipalities cannot afford to overlook. The experiments made at the Pontiac plant show that the profits to be made from these materials may justify considerable initial expenditure in the installation of an efficient plant. The method of digesting and cooking the garbage, as carried on at Pontiac, made it possible to obtain at least 250 pounds of tankage and 43.75 pounds of grease per ton of raw garbage treated. An analysis of this tankage showed it to contain materials of commercial value in quantities as follows: Nitrogen, 3.03 per cent.; phosphoric acid, 3.45 per cent.; potash, 0.9 per cent. Based on this analysis an estimate was made of the value of the tankage per ton. This estimate showed the following figures: Nitrogen, $12.20; phosphoric acid, $2.76; potash, $1.53. Total, $16.49. The price of the nitrogen was figured at 20 cents per pound; the phosphoric acid at 4 cents, and potash at 8.5 cents; these being the prevalent wholesale prices at the time of the test. From these figures it will be seen that there is a value of $2.06 per ton of raw garbage obtainable from this by-product alone, provided it is uniformly as rich as the sample. This is about three times as valuable as the average tankage which is obtained from garbage-reduction plants using solvents to obtain the grease.

However, $6 per ton may generally be taken as a fair average of the selling value of garbage tankage, and on a basis of 250 lbs. per ton of raw garbage, the value available per ton of the raw material is 75 cents. It may be calculated that the grease can be disposed of at 5 cents per pound, which is a conservative estimate, and thus it will be worth $2.19 per ton of raw garbage. The combined value of the by-products is, therefore, $2.94 per ton of raw garbage.

On the basis that five tons of raw material is handled in the plant per day and that it can be disposed of at $2.94 per ton, the gross revenue derived is $15.70. The operating expenses of the Pontiac plant are estimated at $11 per day, not including the smaller items, such as lubricating oils, waste, light, telephone and the larger items of interest on investment, depreciation and maintenance, etc. This operating cost is calculated as follows: One foreman, $4 per day; one assistant, $2 per day; coal, $5 per day; total $11. The net revenue per day when working on a five-ton basis is, therefore, $3.70. A much greater amount of coal was required when the test was being made at Pontiac than would have been necessary had certain changes in the equipment been made previously, such as the installation of a press to assist in drying the tankage and the substitution of an electric drive for the agitator in place of the steam engine then in use.

Many Canadian municipalities could, no doubt, profit by the experience which has been gained at Pontiac. Would it not be better to make a slight increase in initial outlay if by so doing a system of garbage-disposal can be installed in which the profits from the by-products can be made to cover the cost of reduction? The results of the experiment in this United States city have demonstrated that garbage in as small quantities as five tons per day can be reduced on a profit-yielding basis.

Electric Refuse Trucks

By A. Jackson Marshall*

The collection of refuse is a class of municipal service in which motor vehicles are becoming more and more popular. As evidence of what can be accomplished where conditions are of the kind that would generally be termed as decidedly unfavorable, the experience of an English municipality will be found full of interesting and enlightening information.

In Barnes, England, the machines now employed for refuse collection are electric vehicles. An economy of 23 per cent. has been effected since the conversion from horse-drawn equipment, as well as a distinct gain in service rendered.

The adoption of "electrics" by this municipality was decided upon after a 14-day test in which one three-ton machine of the type finally selected was put in service. Its operation was carefully watched and accurate records of mileage, load, current consumption, etc., were kept. The electric vehicles employed have a capacity of 4½ cubic yards, and are capable of a maximum speed of about ten miles per hour. A single charge of the battery is sufficient for forty or forty-five miles. Each truck holds just twice as much as the type of horse-drawn carts regularly used, and is capable of collecting 28 loads per week, as compared with 21 loads for the horse-drawn vehicle. It is estimated that 85 "electrics" now fulfill the same service that formerly required 275 horses.

In this municipality there are large numbers of small houses, and the vehicle is often required to make three or four stops in one minute. The distance between stops may be no more than 15 to 18 feet. The electric truck is particularly suited for such a performance, as it is so readily stopped and started.

A striking point in the operation of the machines is the difference in the time spent by the two kinds of vehicles—horse and electric—in collecting and travelling. Of the 8½ hours in each work day the horse cart spent 2¼ hours in collecting and 6¼ hours in travelling to and from the incinerator, while the "electric" spends 5 hours and 56 minutes in collection and only 2 hours and 34 minutes in travelling.

These electric trucks are fitted with sheet iron bodies with hinged sides which can be let down at a convenient height so that the greater part of the load can be dumped in at the sides direct from the cans on the shoulders of the fillers. Unloading is quickly and easily done by the power of the motor. A worm shaft geared to the motor pushes the body backward about two feet, while inclined tracks at either side tip the body through rollers mounted on its sides. The front end of the body is elevated and the rear end lowered, a discharge angle of 45 degrees being obtained. The entire operation of dumping and drawing the body back to its normal position is accomplished in 7 or 8 seconds by two movements of a convenient switch. The body is galvanized so that it may be flushed out at night with a hose.

The Electric Vehicle Section, National Electric Light Association, has record of another example of the efficiency gained by the installation of electric trucks used for garbage collection in the city of Paterson, New Jersey. Twenty wagons, each with a capacity of three cubic yards were used, with three men on each wagon, a driver and two lifters. There are 150 miles of street in the city to be covered, and in the severe snow storms it was impossible to give the service required. After continued difficulties, followed by many complaints, the city decided to install electric trucks. Although the initial expense was fairly heavy, a saving of

*Secretary Electric Vehicle Section, National Electric Light Association.

$6,000 was the estimate for the first year, and for the second year the saving was figured at $22,000 to $25,000—and the improved service is beyond expectations.

The sanitary department of the city of Boston is also operating electric trucks of five tons capacity, and is finding them extremely satisfactory. The trucks make 25 miles per day in five trips, and the work of each truck is equal to twice or three times the work which would be done by a similar horse equipment.

Municipalities in this country are gradually becoming aware of the efficiency and economy of the "electric" for refuse collection, a fact which has long been realized and taken advantage of in many countries abroad.

Trade Publications

The Armstrong Cork & Insulation Company, Pittsburgh, Pa., are distributing an interesting pamphlet entitled "Fifteen Years on Brine Lines," and a booklet on "Nonpareil Cork-Board Insulation for Cold Storage Rooms." Both publications are illustrated and contain a quantity of useful information. They may be had on request to the company.

Mainly Constructional

East and West—From Coast to Coast

Nanoose Collieries, Limited, has been incorporated with a capital of $50,000, head office at Vancouver.

The Pacific Lime Company, Limited, has been incorporated with a capital of $500,000, head office at Vancouver.

The ventilating system of the new Connaught tunnel on the C. P. R., the last portion of the work, is almost complete.

The Dominion Cement Products Company, Limited, has been incorporated with a capital of $1,500,000, head office at Montreal.

The British Columbia Equipment Company, Limited, has been incorporated with a capital of $100,000, head office at Vancouver.

The New Ontario Contracting Company, Limited, has been incorporated with a capital of $40,000, head office at Port Arthur, Ont.

The East Trail Water Company, Limited, has been incorporated with a capital of $10,000, head office at Trail, B. C., and will operate as a waterworks company.

Building permits issued in St. Catharines, Ont., in the month of November are valued at $17,600, an increase of $400 over the same month last year. The total for the first eleven months of the year is $292,799.

The Canadian Desmond-Stephen Manufacturing Company, Limited, has been incorporated, with a capital of $50,000, and will operate in Hamilton, Ont., for the manufacture of steam injectors and grinding wheel dressers.

The Carter-Halls-Aldinger Company, Limited, the well-known Winnipeg contractors, have been licensed, as an extra-provincial company, to carry on business in the province of British Columbia. Their head office will be at Vancouver Block, Granville Street, Vancouver.

The Anglo-Canadian Engineering Company, Limited, has been incorporated with a capital of $20,000, head office at Winnipeg. The firm proposes to carry on the business of mechanical, hydraulic and electrical engineering and also suppliers of electricity, water and gas, and manufacturers' agents.

The greater activity in Montreal building recently referred to in the Contract Record is reflected in the permits for the month of November. These total $865,530, as compared with $435,745 in the corresponding month last year. For the year to date the value was $5,005,464, as against $5,441,271.

The value of the building permits issued in Galt, Ont., during the month of November this year is $22,700, as against $160 in the same month in 1915. The total value of the permits issued during the first eleven months of the year is $237,795, as compared with $140,149 during the corresponding period last year.

It is now stated that the highway between Ottawa and Prescott is to be built of concrete. The government proposes to undertake the construction of the road directly under the Highway Department, and the legislation providing for the appointment of commissioners will probably be repealed at the coming session of the legislature.

John Macgregor, Limited, Montreal, has obtained a contract for the extension of the forge plant of Canadian Allis-Chalmers, Limited, Rockfield, P.Q. It is on a site 200 x 81, and will consist of a two-storey brick and steel building. The foundations are to be of concrete, the windows of steel sash, and the roof of tar and gravel.

The Canadian Steel Foundries, Welland, Ont., have let a contract to Ryan and Gardner to build two open-hearth furnaces and an extension, 100 feet long, to their machine shop. One new open-hearth furnace has recently been completed, and this, with the new one, will double the capacity of the plant. The total extension will cost about half a million.

The building trades have had a busy season this year in Quebec City. A report prepared by the city engineer's department shows that the building permits issued in the city during the past five years represent an expenditure of $10,000,000, an average of $2,000,000 per annum. In the first ten months of this year the amount reached over $2,000,000.

At their inaugural meeting, held recently at Hamilton, Ont., the Winona District Improvement League discussed the establishment of a concrete highway between Hamilton and Niagara Falls, and the proposal was received with enthusiasm. It is planned to circulate a petition immediately throughout the district, and later to submit it to the Minister of Public Works.

The values of the permits issued at Welland, Ont., during the month of November this year are somewhat behind those of the same month last year, the figures being $15,237 and $32,464 respectively. For the eleven months of the year, however, a considerable increase is shown. This year the total is $191,362, as compared with $171,597 during the corresponding period last year.

Announcement has been made that a new mausoleum will be built in Toronto, which will exceed, in beauty of architecture and permanency of construction, anything that has yet been built on the continent. The design of the structure is in the hands of Mr. Frank Darling, and erection will be under his supervision. Plans will be ready and full announcement made in January next.

The city of Sherbrooke, P. Q., have let a contract for a pump and turbine for the waterworks system to the Canadian Fairbanks-Morse Company, Limited, Montreal. A triple X Gould pump of 4,000,000 gallons Imperial capacity will be used in connection with a William Hamilton turbine at the Drummond plant of the city, working under a static head of 200 feet and a total head of 240 feet.

The Mueller Manufacturing Company propose to make considerable additions to their plant at Sarnia, Ont. New buildings will be erected and new machinery installed to handle the brass work of their large contracts. The number

of employees will, it is expected, be increased from 600 to nearly 1,000. The installation of fire fighting apparatus is also under way and a large tank is being supplied for the local water supply.

Figures issued by Building Inspector McKenzie covering the building permits issued in Vancouver last month are again very encouraging, as compared with those for the previous year. The following shows a comparison of the 1916 and 1915 permits: November, 1916, 38 permits, value $100,695; November, 1915, 32 permits, value $13,800; first 11 months of 1916, 384, value $2,126,524; 11 months of 1915, 583, value $1,566,099.

The brickwork on the new St. James' church at Peterboro, Ont., has been completed, the work having been carried out by Cuff Bros. The total number of bricks used in the structure was 266,500, of which 69,200 were Milton pressed brick. The steel roofing has been completed by Adamson & Dobbin, who have also been awarded the contract for plumbing. The wiring of the building is in the hands of Alexander & Miller. W. R. Turner & Son have the contract for the heating.

The contract for a school at Lennoxville, P. Q., has been awarded by the Bishop's College Corporation to John Quinlan & Company, Montreal. This is one of four buildings, the cost of which will be defrayed by a donation of a million and a half dollars by Mr. J. K. L. Ross, of Montreal. The plans have been drawn by Mr. Kenneth G. Rea, Montreal. A commencement has been made on the structure, of three storeys and a basement, the site being 220 x 60. The foundations are to be of concrete and the construction is of stone, concrete and plastic brick. The floors will be constructed of concrete with oak covering, and the plastering is of hardwall plaster, with metal lathing.

At a meeting held in London, Ont., which was attended by a large number of the city's business men and representative citizens from adjoining counties, the following resolution was passed: "That this meeting support the proposal that there should be a Department of Municipal Affairs for Ontario, and also that a town-planning act should be passed to give municipalities greater power to regulate their development on the lines advocated by the Conservation Commission." The gathering was addressed by Mr. Thomas Adams, the Government town planning expert, and included county councillors, Board of Trade members and others interested in municipal government from the counties of Middlesex, Oxford, Perth, Elgin, Essex and Lambton, who were the guests of the London Board of Trade.

Personals

Mr. Thos. Adams, of the Commission of Conservation, recently addressed the Canadian Club at Quebec on the subject of town planning.

Mr. Roadman M. Lee, of South Vancouver, has been transferred from the sewerage office to the engineering department, as assistant to Municipal Engineer Bennett.

Mr. G. H. Tripplehorn has resigned his position with the Chatham Cement Tile Company, with which he has been associated for a number of years and has gone to Detroit, where he will assume the management of a cement company.

Mr. David Johnston, engineer of Saanich Municipality, Vancouver Island, has resigned his position to enlist with the Sixth Field Company of the Canadian Engineers. Mr. Johnston had formerly been municipal engineer in Point Grey, B. C.

Mr. E. V. de Bury has been appointed general sales agent at Montreal of the Dominion Iron and Steel Company, Limited. Mr. de Bury was formerly president of the B. and S. H. Thompson Company, and has also been associated with the Page Hersey Iron Company, the Peck Rolling Mills, and the Ontario Iron and Steel Company.

Mr. W. H. Fortier, of the Dominion Glazed Cement Pipe Company, and Sanitary Engineer Dalzell, of Vancouver, will, at the request of the Vancouver Board of Works, make tests regarding the relative merits of cement pipe and vitrified pipe, and submit a report.

Mr. J. A. MacDonell, formerly head of the contracting firm of MacDonell, Gzowski & Company, Vancouver, who went overseas with the First Canadian Pioneers, has been promoted to the command of that corps. He has also been recommended for the D.S.O.

Mr. Geo. S. Rice, chief engineer of the United States Bureau of Mines, Washington, D.C., has been engaged by the British Columbia Government to make an investigation of the Coal Creek coal areas of the Crow's Nest Pass Coal Company, near Fernie, with regard to the causes of certain accidents which have resulted in the death of a number of workmen.

Obituary

Lieut. B. H. A. Burrows, of Toronto, son of Mr. Acton Burrows, of Acton Burrows Ltd., Toronto, is reported to have been killed in action on the battle line in France. Lieut. Burrows was an engineer by profession, having worked for some time at the G. T. R. shops in Stratford, and also with the Canadian Allis-Chalmers Company, Toronto, and the Coleman Fare Box Company, Tottenham. The late Lieut. Burrows was educated at the Toronto Model School, Harbord Street Collegiate and Toronto University, where he took a course in mechanical engineering and obtained the degree of B.Sc. In September, 1915, he joined the Canadian Engineers, and at Rockcliffe Camp, Ottawa, he received his commission. He was a student member of the Canadian Society of Civil Engineers.

Holding Power of Nails

Some very interesting tests of the holding power of nails have been made at the government arsenal at Watertown, Mass., and the results may be briefly summarized as follows:

The tests were made in pine and spruce, with both cut and wire nails. The nails were of all sizes from 1⅛ inch to 6 inches in length. In every case the cut nails showed superior holding strength by a large percentage.

In spruce, in nine different sizes of nails both standard and lightweight, the ratio of tenacity of cut to wire nails was about three to two.

With the finishing nails the ratio was 3.5 to 2. With box nails 1¼ to 4 inches long, the ratio was three to two. The mean superiority in spruce wood was 61 per cent.

In white pine, cut nails, driven with taper along the grain, showed a superiority of 100 per cent., and with taper across grain, of 135 per cent. Also when the nails were driven in the end of the sticks along the grain the superiority of cut nails was 100 per cent., or the ratio of cut to wire nails was two to one.

The total of the results showed the ratio of tenacity to be 3.2 to 2 for the harder wood, and about two to one for the softer.

This gives a hint as to where we may use each kind of nail to advantage. For example, in laying a floor, where the travel over it naturally tends to loosen the boards, it will pay to use cut nails. Other instances might be cited, but this one will suffice.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Cayuga, Ont.
The Town Council are considering the installation of an elevated tank and hydrants for fire protection. Clerk, J. W. Sheppard.

Dartmouth, N.S.
The City Council contemplate the construction of water and sewer extensions, estimated to cost $5,000. Clerk, Alfred Elliott.

Guelph, Ont.
Manager Foster, of the Water Commission, has recommended the installation of a permanent chlorination plant at the Pumping House. City Clerk, T. J. Moore.

Hamilton-Niagara Falls, Ont.
The construction of a cement roadway between Hamilton and Niagara Falls is being considered jointly by the Provincial Government and the Municipalities concerned.

Lindsay, Ont.
The Town Council contemplate the installation of a sewage disposal plant, and data will be secured by Mayor Kylie. Clerk, D. Ray.

St. John, N.B.
The City Council propose to pave a number of streets next season with bituminous concrete, granite block, sheet asphalt and asphaltic concrete, at an approximate cost of $239,390. Particulars from Commissioner R. W. Wigmore.

Stellarton, N.S.
The Town Council contemplate the construction of pavement and sidewalks at an approximate cost of $50,960. Clerk, J. W. Henderson.

Toronto, Ont.
Works Commissioner Harris has recommended the following works:—granite block pavement, $34,609; asphalt pavement, $48,633; bitulithic pavement, $176,707; concrete sidewalks, $2,298.

Victoria County, Ont.
The Roads and Bridges Committee of the County Council have adopted a report advocating a Good Roads System for the County. Clerk, J. R. McNeillie, Lindsay.

Winnipeg, Man.
In connection with the proposed watermain on Academy Road, the City Council will purchase about 1,200 feet of 8-inch cast iron pipe, three hydrants and three valves.

The construction of a sanitary sewer on Centennial Street is being considered by the City Council. Approximate cost, $6,073. Clerk, C. J. Brown.

CONTRACTS AWARDED

Deacon, Man.
The Greater Winnipeg Water District, 901 Boyd Building, Winnipeg, have awarded the contract for the erection of an extension to the engine shed to the Progress Construction Company, Limited, St. Boniface, Man. Frame construction. Approximate cost, $3,250.

London, Ont.
The City Council have awarded the contract for construction of a 10-inch sanitary sewer on Bathurst Street to Goodwin, McCallum & Judge, 643 William Street. Approximate cost, $16,000.

Tilbury West Township, Ont.
The Township Council have awarded the contract for dredging for the Big Creek Drain to the Windsor Dredging Company, 33 Chatham Street West.

Railroads, Bridges and Wharves

Muncey, Ont.
The Michigan Central Railway propose to build a steel and concrete bridge, and will do the work under the supervision of their Superintendent, M. Fenwick, St. Thomas. Approximate cost, $35,000.

Port Arthur, Ont.
The Industrial Committee have recommended to the City Council that a bridge be built immediately over the McIntyre River. Clerk, T. F. Milne.

Public Buildings, Churches and Schools

Fredericton, N.B.
The School Board propose to start work in the spring on an annex to the school on Charlotte Street. Chairman, Dr. G. C. VanWart.

Hamilton, Ont.
The erection of a Sunday School in connection with the Jewish Synagogue at Hess and Peter Streets is being considered. Brick construction. Approximate cost, $10,000. Superintendent, M. Grossberg, 184 Hess Street North.

London, Ont.
Building Inspector A. M. Piper has been instructed to report on a steam heating system for the City Registry Office, and tenders will be called next month.

Preston, Ont.
The Congregation of the Methodist Church contemplate the erection of an annex to their church, at an approximate cost of $15,000. Pastor, Rev. David A. Walker, Queen Street.

Quebec, Que.
It is probable that the architect for rebuilding the Parish Church of Limoilou will be J. P. Ouellet, 28 St. Famille St.

St. Benjamin, Que.
Plans are to be prepared for interior work to the Parish Church and tenders will be called in January. Architect, P. Levesque, 115 St. John Street, Quebec.

St. Jean de Dieu, Que.
Tenders on the erection of a church will be received until December 30th by the Curate, Rev. J. A. Ouellett. Plans and specifications with the architect, P. Levesque, 115 St. John Street, Quebec, and with the Curate. Stone and steel construction. Approximate cost, $60,000.

Toronto, Ont.
It is probable that the Provincial Department of Public Works will include in their estimates the sum of $250,000 for the erection of an annex to relieve the overcrowding in the Parliament Buildings.

The Directors of the Women's Cottage Hospital and Dispensary, 125 Rusholme Road, propose to start work in the spring on the erection of new buildings. Architects, Gordon & Helliwell, Confederation Life Building. Approximate cost, $125,000.

The Board of Governors of the Western Hospital propose to have plans prepared at once for the rebuilding of the west wing.

CONTRACTS AWARDED

Hull, Que.
In connection with the erection of a church for the Parish of Holy Redeemer, the contract for heating has been let to J. A. Langelier, 310 Wellington Street, Ottawa, at $3,750, and the contract for electrical work to E. Martel, Hull.

New Toronto, Ont.
In connection with the erection of a school for the School Board, the following contracts have been let:—carpentry, F. Wilson, 41 Beaconsfield Avenue, Toronto; painting, R. G. Johnston, 17 Galley Avenue, Toronto; plastering, Chamberlain & Son, Long Branch, Ont.

Quebec, Que.
The contract for ventilating system for the college which is being erected for the Commercial Academy has been let to E. Falardeau, 308 Queen Street, and the contract for heating to F. Gingras, 34 St. Augustin Street.

The following contracts have been let in connection with the hospital which is being built for the Anti Tuberculosis League:—supply of stone, Chateauvert Quarry Company; supply of brick, Citadel Brick & Paving Block Company, 42 Dalhousie Street; roofing, E. Falardeau, 308 Queen Street; painting, O. Lachance, 25 Eden Street; plastering, J. Gossilin, general contractor.

Business Buildings and Industrial Plants

Calgary, Alta.
Burrell & McDonnell, Old Herald Building, Centre Street, have prepared plans of a business block for A. F. H. Mills, Eighth Avenue West. Reinforced concrete and hollow tile construction. Estimated cost, $5,000.

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Protection or Coercion?

THE architects of the province of Quebec are urging the passage of a Bill through the Local House which, though excellent in its intentions, does not seem to accord exactly with modern ideas of democracy. They say, in effect, that no one shall call himself an architect, or practise as such, who does not belong to the provincial architects' association. So far, good. The Bill, according to reports, however, goes further, and demands that no building shall be erected except under the guiding hand of some member of this association. This, as we read it, is coercion. It is as if the medical profession should say that nobody can legally have a headache who is not attended by some member of the medical association, or as if a plumber should say one may not install a new washer on a leaky tap in one's own house.

The ideal and aim of associations appear to have been entirely lost sight of by Quebec architects, if the report of the matter as it reaches us is correct. Such an association ought to have as its object the establishing of a standard for the protection of the public. Membership in such an association ought to mean to an architect what a trademark means to certain manufactured goods. Just as the public buys these goods because the trademark stands for quality and service, so they would employ a member of this architects' association, but who has any right to say that the public shall buy any particular goods?

This is a free country, yet, and will continue to be so unless we lose this war or get some such arbitrary legislation as this on our statute books. If I want to build a house without employing an architect and can satisfy the authorities that I am meeting the legal requirements, then no British law will ever be passed to stop me. On the other hand, if I decide to employ an architect, the government ought to guarantee me that anybody trademarked "architect" represents the real thing. That is a protection due to the architect and the public alike. But, as between protection and coercion, there is a great gulf fixed.

Road Maintenance in Quebec

REFERENCE has been made in previous issues of the Contract Record to the importance which the Quebec Government attaches to the maintenance of roads, supplementing their policy of more and better roads. The Government recognizes the necessity for increased vigilance in the matter of repairs, which has been again and again insisted on by highway engineers, and the Bill introduced by the Hon. J. A. Tessier, Minister of Roads, proposes to centralize the control of the work by placing it under the charge of the Roads Department. In this way, it is believed that economy and efficiency will be more readily attained.

The roads are divided into two classes, provincial and municipal, and the Bill deals chiefly with the latter (built under the Good Roads Act), as it is in this class that the greatest lapses in maintenance are likely to occur. The main principle of the Bill is control by the Government, which will pay a proportion of the cost of maintenance. The amount to be contributed by the Government to municipalities is a subsidy of not more than fifty per cent. of the expenses of such municipality incurred for the improvement, repair and maintenance of its roads, whether gravel, stone, or built in any manner considered permanent, provided such subsidy does not exceed, in any year, the sum of $400.

The bill provides machinery for carrying out its main objects. Thus the Roads Department will make an estimate of the cost of the work on municipal roads, indicate how it is to be done, and the time for its completion. On receiving this information, a special meeting of the council will be held, and within seven days from the meeting the decision of the council is to be forwarded to Quebec. If the municipality desires to do the work, the date of its commencement must be stated. If the date is deemed too far distant by the Minister, or if the decision of the council is not forwarded within the seven days, or if the Roads Department is asked to do the work, the Minister has the power to at once take the necessary steps to carry out the improvements. In order to prevent disputes as to the amount which is due to the Government for the work, it is provided that "The certificate of the Minister of Roads shall be final, and shall establish beyond dispute that such debt is exigible from the municipality in question." Whatever amount is due to

the Government will be collected by means of a special collection roll.

The provincial highways are those constructed under authority of the Lieut.-Governor-in-Council, and include the main highways lately built. The municipalities, at the decision of the Minister, will have to contribute up to 50 per cent. of the cost of upkeep of these roads. The certificate of the Minister as to the amount due by a municipality will be final. Such questions as to the repairs, time when the work will be done, and when municipalities will be charged with their proportions are left to the Minister to decide.

It will be seen that while the Government will pay a subsidy for improvements on municipal roads, the municipalities in turn are bound to pay a share of the cost of keeping up the main highways. The Bill is an effort to make the general community bear the cost of the maintenance of all the roads and to control that cost from a centralized authority.

The Government have been asked to construct a large number of new roads. The advocates of a proposed road from Levis to Chambly, on the South Shore, are particularly insistent, while the members interested are asking for highways from Levis to Rimouski, Sherbrooke to Quebec, and many other roads. Mr. Tessier told the members that it was impossible to satisfy all the demands, and that the Government cannot undertake a new series of roads. He suggested that the municipalities should build their own roads, under the provisions of the Good Roads Act.

Iron and Steel Production

THE report of the Department of Mines on the production of iron and steel in Canada during the calendar year of 1915 is just to hand. Active mining operations were conducted at three mines only during the year, namely, the "Helen" and "Magpie," in the Michipicoten district, and the "Moose Mountain," north of Sudbury, all in Ontario. Small shipments were made from stock at two other properties. The total shipments during the year were 398,112 tons, as compared with 244,854 tons the previous year. Of total shipments, 308,382 tons were sent to blast furnaces in Canada and 89,730 tons to the United States. The following table indicates the production of iron ore by provinces during 1913, 1914 and 1915:—

	1913		1914		1915	
Provinces	Short tons	Value	Short tons	Value	Short tons	Value
New Brunswick . .	86,416	$153,820	4,775	$10,841	3,683	$ 8,261
Nova Scotia	20,436	21,049	.....	.....	.....	.....
Quebec	5,102	26,999	.....	.....	.....	.....
Ontario	195,680	427,975	240,079	531,200	394,429	766,166
	307,634	629,843	244,854	542,041	398,112	774,427

The year 1915, especially the latter part of it, was marked by a steady renewal of activity in the iron and steel industry, due, largely, to the requirements of steel for munitions and the export demands for billets and wire. The value of iron and steel goods imported has gradually decreased from $105,614,450, in 1912, to $74,308,983, in 1915. On the other hand, exports have increased from $10,682,484, in 1912, to $48,268,148, in 1915.

Montreal Tramways Franchise

A deputation from the Montreal Builders' Exchange have requested Sir Lomer Gouin to settle the question of a new franchise for the Tramways Company. The deputation emphasized the importance of the need for a definite legalized method of handling freight by the company. The latter now carry freight on sufferance, but this should be made regular because it cheapens the cost of haulage and so reduces the cost of building and many other commodities as well as the road work, thus benefiting the property owners directly. This privilege also saves a tremendous amount of wear and tear on the roads and pavements of the city and reduces the number of teams and trucks on the already too narrow streets; in this way helping to avoid congestion. The deputation consisted of Messrs. James Ballantyne, past president; J. P. Anglin, vice-president; R. F. Dykes, director; A. W. Bremner, director; T. A. Morrison, and D. K. Trotter, secretary of the exchange.

Calgary Branch C.S.C.E.

The fourth annual general meeting of the Calgary Branch of the Canadian Society of Civil Engineers was held on Saturday, December 2nd.

A canvass of the ballots for the election of officers for the ensuing year gave the following results:—Chairman, A. Scott Dawson; secretary-treasurer, Sam G. Porter; executive committee, past chairmen Wm. Pearce and F. H. Peters, ex officio; and C. M. Arnold, Capt. H. Sidenius, M. H. Marshall; auditors, J. S. Tempest, S. K. Pearce.

The program of meetings for the season is only partially completed. Capt. H. Sidenius, Headquarters Staff, Military District No. 13, will speak on "Military Engineering and Trench Warfare" at the December meeting. At the January meeting a joint paper will be presented by G. W. Craig, city engineer, and J. F. Green, bridge engineer for the city of Calgary, on the new Centre Street Bridge, Calgary. This is a reinforced concrete arch bridge, just being completed at a cost of about $375,000. The address will be illustrated with lantern slides.

Cement Gun Talk before Toronto Branch C.S.C.E.

The regular monthly meeting of the Toronto Branch of the Canadian Society of Civil Engineers was held in the Chemistry and Mining Building of the University of Toronto on Friday, December 15. The meeting was addressed by Mr. B. C. Collier, general manager of the Cement Gun Company, Allentown, Pa., on "The Uses and Applications of Cement Mortars." The lecture was a description of the cement gun and the widespread uses of its product. Mr. Collier spoke of the incidents which led up to the invention of this machine, and explained that it was regarded as such an important addition in the field of scientific appliances that its inventor received from the Franklin Institute the medal "To the Most Deserving." By means of a large number of lantern slides the speaker portrayed the extensive uses to which the cement gun has recently been put, and illustrated the advantages claimed for "Gunite," as the product of this machine is known. Moving pictures also exhibited the methods of cement gun operation and the processes of applying the mortar. A lengthy discussion followed the presentation of the address.

Britains answer to Germany's so-called offer of peace is another unanimously voted credit of $2,000,000,000.

Large Stadium for McGill University

Recently Completed in the City of Montreal—Ultimate Seating Capacity 20,000 — Constructional Details.

By Mr. Wm. D. Lawrence*

THE McGill Stadium, recently completed, marks the initial step in the development of the property presented to the University by Sir Wm. McDonald in 1911, and now known as McDonald Park. This property, situated on the slope of Mount Royal, extends east and west from Pine Avenue to the Incline Railway, and north and south from Fletcher's Field to University Street, and covers an area of about 25 acres. The projected development includes the erection of gymnasium, armoury, and skating rink adjoining Pine Avenue. To the rear of these buildings and covering the central portion of the property is the Stadium, and back of the stadium will be the student residences.

As the old university campus had become inadequate for the growing athletic needs of the university, the Graduates' Society agreed to undertake the building of the new stadium and appointed a committee under whose supervision plans were prepared and the contract for the work let in July, 1914. It was the original intention to have the playing field completed for the fall of the year, but the outbreak of war led to a change of plans and deferred the completion of the work to September, 1915.

General Description

The area reserved for stadium purposes is roughly oval in shape with extreme dimensions of 750 by 400 ft. The layout includes a quarter-mile cinder track inside of which lies the playing field; on the southeast side

General Lay-out of the McGill Stadium

of the track is a parking space for automobiles, 48 ft. wide by 450 ft. long, and on the northwest side is the reinforced concrete grandstand, with a seating capacity of 8,300. A driveway and sidewalk encircles the whole stadium, and at each end the sloping banks between the sidewalk and running track are for the present to be sodded, but are reserved for future grandstand extension, allowing for an ultimate seating capacity of about 20,000.

* Consulting Engineer, Montreal.

General Features of Design

The site available for stadium purposes was on a sloping hillside, the level of the ground varying from about elevation 120 at the southeast side to elevation 175 at the northwest side. The level of the finished field was fixed at elevation 134, and it was necessary to build a retaining wall along the southeast side up to this level, filling in the space behind same. On the upper half of the site the excavation had to be carried into the side of the hill the necessary distance to give the area required for the field and track, and the side of the excavation sloped off to allow the necessary space for the building of the grandstand.

The finished grade of the road at the rear of the stand was at elevation 180, and the back of the stand is two feet above this level, the entrances to the stand being directly from the sidewalk level. The road level along the front of the retaining wall is at elevation 123, and the road encircles the end of the stadium rising on a maximum grade of 9 feet per hundred to the required level at the rear of the stand.

Clearing Site

The greater part of the stadium site at the time of starting the work was covered with a fairly heavy growth of large elm, walnut and other trees, together with smaller second growth material. This was cleared off in the usual manner by cutting the trees and grubbing the stumps. Dynamite was also used to remove the stumps, but it was in general found cheaper to remove them entirely by grubbing as, after dynamiting, there always remained a certain amount of grubbing to be done.

In addition to clearing the trees, there were two houses to be demolished, together with a stable and several smaller buildings.

Excavation

The material to be excavated consisted of a top layer of good rich loam overlying a clayey loam containing a fair percentage of boulders, and, below this, solid limestone. The depth of the covering overlying the rock averaged about three feet. The rock itself consisted of a top layer of shaly material about two feet thick, which could be removed by a steam shovel without dynamiting, and below this was the hard, dark colored limestone.

The earth and shaly rock were removed with a Bucyrus ⅝ yard revolving steam shovel wherever of sufficient depth for the shovel to operate, and by pick and shovel, being loaded into dump wagons and hauled to the fill behind the retaining wall, and to the road embankments at the ends.

The rock was a hard, dark colored limestone, lying in nearly horizontal strata, but was intersected by a number of small dykes of igneous rock, and at each end of the field there were two large dykes of extremely hard rock. The drilling was done with Ingersoll steam drills, steam being supplied by a portable horizontal boiler, and there were generally three of these drills in operation. The lineal feet drilled per day varied greatly, depending on the depth of holes and quality of the

rock. The maximum day's work recorded was 300 feet by the three drills, but the general average per drill varied from 50 to 70 feet per day. Each drill was operated by one mechanic and one helper. The working face of the rock varied from nothing, when starting into the hill, to a maximum of about 25 feet.

In blasting the rock it was impossible to do any very heavy charging owing to the close proximity of the Royal Victoria Hospital, and in the deeper holes the charge was generally about half a stick per foot of depth—40 per cent. dynamite being used, while the shallow holes had to be charged lightly and protected as well with a heavy steel plate, as otherwise the rock was liable to fly to a considerable distance.

The rock after blasting was broken into crusher size by sledges, and loaded by hand into dump cars of one cubic yard capacity running on a narrow gauge track. There were two separate loading gangs at work consisting of five to seven men to a car, and each gang had either two or three cars coupled together to keep busy. The cars were hauled to the crusher by a single horse, and as the haul was in some cases about 700 feet the locomotive was kept fairly busy. As soon as one set of three empty cars was returned to one gang to load the other set was filled ready to be hauled to the crusher, and there was no lost time in the loading and hauling as during the time the cars were being hauled the loading gang were busy breaking the rock and getting it into position to be readily loaded on the cars.

The maximum day's record for breaking and loading into cars was ten yards per man, but the general day's average was about six or seven yards solid measurement.

The approximate quantities of excavation were 23,000 cubic yards of earth, and 35,000 cubic yards of rock, 25,000 cubic yards of which was suitable for crushing.

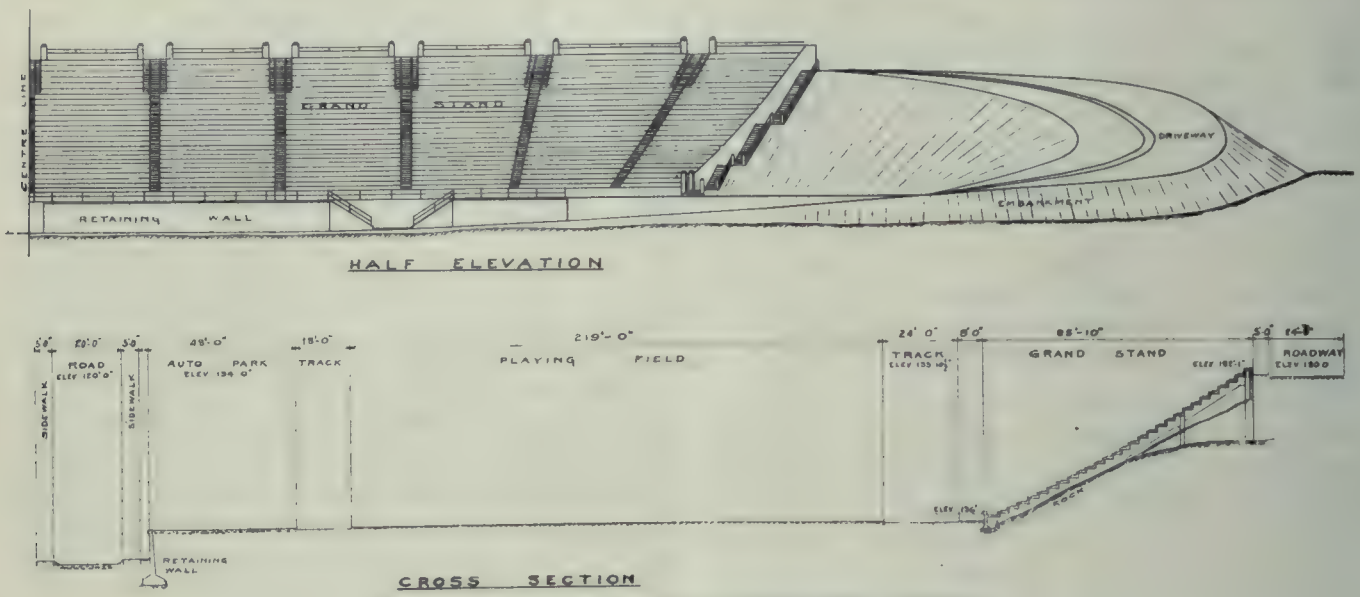
Crushing Plant

The crushing plant consisted of a Reliance jaw crusher of about 40 tons per hour capacity, with bucket elevator, rotary screen, and storage bins, the plant being driven by a 45 horse power electric motor.

The stone was fed to the crusher by an inclined chute lined with steel plates, and set at a slightly flatter slope than that at which the stone would slide by gravity. The stone was dumped directly into this chute from the cars, and in order to prevent the rush of stone when the cars were dumped from blocking the opening to the jaws a temporary plank was placed across the chute to stop the first rush, and the stone was then fed to the jaws by laborers standing at the side of the chute and raking the stone down as required with bent bars.

From the crusher the stone was elevated by a bucket elevator and screened on a rotary screen with ½ in., ¾ in., 1 in. and 2 in. openings. The average run of the crushing was:—rejects (about 3 in. size), 38 per cent.; 2 in., 22 per cent.; 1 in., 16 per cent.; ¾ in., 14 per cent.; dust, 10 per cent. The stone dropped from the screen directly into storage bins, and was hauled from these to the stock pile by ordinary two-horse dump wagons.

The crusher operating gang consisted of a foreman, who also looked after the machinery, and five laborers who were busy most of the time on the feed chute, while two wagons were kept busy removing the stone from the bins. The maximum amount crushed per day was 180 cubic yards solid measurement, which, with the jaw opening used, was about the maximum capacity of the crusher. This crushing outfit gave splendid satisfaction, and during the ten months it was in practically continuous operation without trouble or delay.



Half Elevation and Cross Section of the McGill Stadium, Montreal

Playing Field

In the construction of the playing field the whole area of the field where excavation was necessary was excavated to a depth of two feet below the finished grade, and where the ground was filled the material was thoroughly compacted with a steam roller, so that no future settlement would take place. The first 18 inches of the field fill consists of the earth taken from the excavation which was levelled and rolled. The top 6 inches consists of the loam stripped from the original surface. In this was mixed a certain proportion of manure and also of sand, the whole being well raked and mixed and lightly rolled, all stone and gravel being removed. The finished surface is crowned 12 inches higher in the centre than at sides, so as to facilitate the drainage and quick drying out of the field. Particular care was taken to obtain an accurate crown, and also a good springy field. The whole of the field was then sodded, a particularly good grade

of sod being obtained, and as soon as the sod had taken the inequalities were rolled out. The result is a fine springy field that amply repays the care taken in its construction.

The goal posts are set in boxes in concrete bases, the top of the boxes being 6 inches below the surface, and at any time the posts can be readily removed, a cover placed over the boxes and the space above filled with earth, leaving a clear field surface.

There is a wood curb consisting of a 2 in. x 8 in. plank on edge between the playing field and the track, having its top level with the surface of the sod, the surface of the track being 1½ inches lower. This curb is accurately shaped to conform to the curve of the track, and besides keeping the inside line of the track in a fixed position, also forms a protection for the edge of the playing field turf.

Running Track

The track is a quarter of a mile long, measured 18 inches from the inside or pole line, this being the Intercollegiate requirements. The straight portions of the track are 271 feet long, and the curved ends have two different radii, the starting curve being of 168 feet radius and the end curve of 103 ft. radius. The track is 18 feet wide, except the stretch in front of the grandstand, which is 24 feet wide. This stretch allows ample space for the 100 yards dash and the 120 yards hurdles to be run straightaway. The maximum banking at the ends of the track is 12 inches.

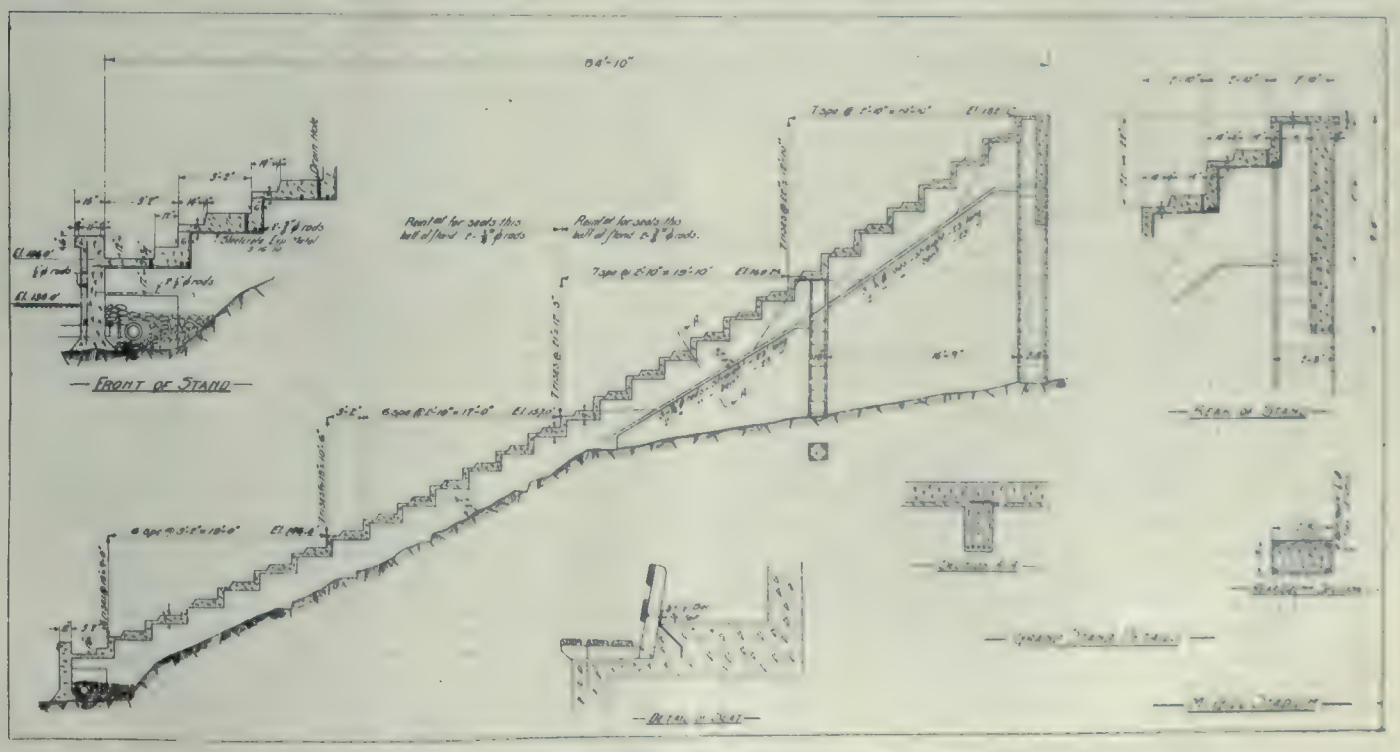
The track is built partly on the solid rock and partly on the filling ground, 24 inches being allowed for the track material. All of the fill under the track was thoroughly compacted with a steam roller. The base course consists of 12 inches of broken stone of varying sizes from 3 to 6 inches, and was well rolled and compacted with a steam roller. On top of this base course was first placed a 3-inch layer of coarse cinders, which was kept well wetted and rolled with a 3,000 lb. roller, sufficient rolling being given to compact the cinders, but not to grind them into the base course. An additional 5 inches of coarse cinders was then added in two courses, each course being kept wet and thoroughly rolled. Over the top of this was then spread a thin layer of clay which was washed into the cinders to form a binder. The balance of the track was built up of thin layers of fine cinders which were constantly kept wet and rolled until the track was built up to the required level. The top inch or so was spread on by hand and the levelling done by laborers experienced on track work.

Particular care had to be given to the quality of the the cinders used in the track, and also to the amount of rolling given same in order to get a firm, springy track; and, even with the care given, there were some spots in the track which kept soft during the fall of 1915, but these spots, after standing through the winter, re-rolled firm and satisfactory in the spring.

Drainage and Water Supply

The drainage system includes the draining of the grand stand, playing field, and running track. The grand stand is drained by holes through the floor of the stand, and the water running down the rock slope underneath is collected in 4 in. sewer tile drains, laid with open joints behind the front wall of the stand. These drains are connected to two 6-in. main drains, which are carried directly across the field to manholes on the southeast side, and from these a 9-in. drain is connected to the city sewer on Pine Avenue. Side branches of 3-in. farm tile are carried underneath the playing field from the 6-in. main drains, and the field drainage is collected by these. For the track drainage openings are provided in the curb at the side of the track connecting directly with the ends of the farm tile drains and also with the drains running parallel with and alongside of the track, giving drainage openings about 40 ft. apart.

Provision has been made by means of cut-off valves on the 6-in. drains at each manhole to close off the drains during periods of dry weather, so as to hold the water in the soil. Also while these valves are closed



Details of construction of Grand Stand, McGill Stadium, Montreal

the water supply can be connected to the drainage system so as to sub-irrigate the playing field.

This drainage system has proven very satisfactory, and both track and field are clear of pools of water during the heaviest rains, and dry out very readily.

The water supply consists of a 4-in. cast iron main, brought from Pine Avenue and carried along under the auto park, with two hydrants placed alongside of the retaining wall. These hydrants are at present used for hose connections for watering the field, but are also to provide future fire protection for the buildings to the southeast of the stadium. From this 4-in. main there are two 2-in. galvanized iron pipes carried across the playing field, being laid in the same trench as the 6-in. drains, and these two pipes are connected into a loop along the front of the grand stand. Two branches are also taken off to the ends of the playing field. There are thus two hydrants, two hose connections at each end of the field, and three hose connections along the front of the stand, which can be connected to for watering the field, so that no long lengths of hose are necessary. The hose connections at front of stand can also be used for washing down the stand, and as the available pressure at the playing field level is 95 pounds, all parts of the stand can be easily reached.

Excavating for the new Stadium

A portion of the Grand Stand

Retaining Wall

The retaining wall along the southeast side of field is of the usual reinforced concrete type, the reinforcement being square twisted rods. The base of the wall rests on the solid rock, and the height varies from a maximum of 21 ft. at the north end to 5 ft. at the south end. There are two sets of stairways from the roadway to the field built as part of the wall, and each end of the wall is curved to conform to the general layout. The wall was built in 40-in. sections, with expansion joints between sections, and it might be noted that the recorded movement at each of these joints under extremes of temperature is about one-sixteenth of an inch. The exposed surface of the wall immediately on removal of the forms was given a brush coat of cement mortar, to produce an even color, all form marks being rubbed smooth; the top of the wall is finished with a 2-in. pipe railing. The total amount of concrete in the wall, including stairways, is 508 cubic yards.

Grand Stand.

The grand stand is a reinforced concrete structure 86 ft. wide by 440 ft. long at the front and 540 ft. long at the rear. The central section of the stand for a length of 287 ft. is straight, and the ends are curved to conform to the shape of the field. The stand is divided into twelve sections, with aisles 3 ft. 6 in. wide between sections, and there are 28 rows of seats in each section. Each seven rows of seats has a different rise and width, giving a concave shape to the face of the stand. The rise is such that a clear view of the field is obtained by the spectators over the heads of those in front. The width allowed to each seat is 18 in., and the total seating capacity is about 8,300.

The deck of the stand is of reinforced concrete, the risers being designed as beams to carry the load to the main supporting beams, which, on account of the shape of the ground, rest on the rock for the lower half of the stand, and are carried on columns for the upper part. These risers are 6 in. thick and are reinforced with 2¾-in. rods. The deck slab between risers is of varying thickness, so as to give a comfortable seating rise, and is reinforced with Steelcrete expanded metal. This expanded metal is carried continuously from bottom to top of stand through slabs and risers.

The rock surface was in all cases excavated to a minimum depth of 2 ft. below the bottom of the concrete deck, this space being necessary for the drainage under the stand and also for the removal of the forms. Each section of the stand is built as a separate unit, and has a row of supporting beams at each end and one in the centre. These beams, as before mentioned, rest partly on rock and partly on supporting columns, the columns in all cases being carried down to the solid rock. The columns under the centre of the stand are 18 in. square and reinforced with 4¾ in. square rods, with ⅜ in. ties every 12 in., while the columns at the rear of stand are 18 in. x 32 in. in section, and reinforced with 4⅞ in. square rods and ⅜ in. ties. These rear columns are connected by a 12-in. curtain wall, to hold back the road embankment, so that the rear columns act both as beams and columns. The beams at the end of each section have a shoulder 3 in. wide, to support the aisle slabs, and these aisle slabs were poured after the seat sections were completed, two layers of tar paper being placed in the joint between the two. Thus any longitudinal expansion and contraction of the stand is localized to each section, and the movement takes place at these joints. No longitudinal expansion joints were provided, as they were not thought necessary, and after passing through one year's extremes of temperature, no cracks have developed in any part of the deck, though a distinct longitudinal movement takes place at the joints provided.

In placing the concrete the mixer was placed at the rear of the stand, and a runway for the concrete dump wagons built along the back. From this runway the concrete was spouted into place through a circular galvanized iron spout, the slope of the stand being such that this spout could lay on the forms and allow the concrete to flow. The lower end of the spout could be moved from side to side, and as the spout was made in

short, removable sections, the concrete could be readily distributed to place, starting from the bottom and working up to the top, and removing sections of the spout as required.

The mix of concrete used was 1 part of cement, 1 part of sand, 1 part of stone dust, and 4 parts of ¾ in. stone. The surface was floated smooth with a wooden float, no other special finish being given. The amount of concrete in the stand is 2,000 yards.

The seats are made of ash slats ¾ in. x 3¾ in. with hardwood standards about 3 ft. 6 ins. apart, which are securely anchored to the concrete, and are so built that the whole of the concrete surface can be readily washed down with a hose, drainage holes being provided about 6 feet apart along each row of seats. All woodwork is protected with three coats of paint.

There are special stairways at each end of the stand to give access from the roadway at the rear to the field, and there is a 3-inch iron railing along top of wall at the front of stand and also at the rear. Eleven entrances and aisles provide adequate accommodation for access to the stand, and each of these entrances is provided with a special gate which can be locked at a 3 ft. 6 in. width when filling stand to facilitate the taking of tickets, and opened out to a 9-ft. width when emptying stand.

Automobile Park

A parking space for automobiles is provided at the southeast side of the field for the convenience of those preferring to watch the games from their cars, and also as parking space for empty cars during the progress of the game. There are no special features in its construction, the surface being finished with an ordinary macadam finish.

Conclusion

The members of the Graduation Construction Committee in control of the work were Messrs. W. M. Molson, N. M. McLeod, and A. P. S. Glassco. The general contractors were L. A. Ott & Company, of Montreal, whose engineer on the work was DeSalaberry Beaudry, As. Mem. C. S. C. E. The writer was engineer-in-charge of the work for the Construction Committee from October, 1914, until completion. Credit is also due to Mr. T. Graydon, grounds superintendent of McGill University, for much useful help and advice in the construction of playing field and running track.

New Bill to Protect Quebec Architects

A BILL has been introduced into the Quebec Legislative Council by the Hon. J. L. Perron, which will make it impossible for any person to act as architect without being a member of the Province of Quebec Association of Architects. The association objects to any person calling himself an architect without being a member, and legal action has been several times taken, under the Act constituting the association, against persons alleged to be practising illegally. A recent judgment of the Court of Review, however, proved unfavorable to the contention that persons acting as architects are bound to be members of the association. The object of the Bill is to remedy the defect, and the measure is also aimed at persons, outside the association, including engineers, who design buildings, particularly industrial plants, work which it is claimed is wholly within the architectural sphere. The wording of the Bill is very comprehensive and apparently will prevent contractors from building for proprietors without an architect being consulted. No one who is not a member of the association may act as an architect "directly or indirectly" without incurring penalties named in the Bill, a provision which on the face of it looks as if it will affect the hundreds of small contractors who build without calling in an architect.

The Bill gives the Council of the Association discretion to admit to its membership all members of associations of architects in the other provinces of Canada, also members of the Royal Institute of British Architects, and of foreign associations of architects of equal standing on their presenting their credentials.

Architects, not members of the associations, who shall have practised for five years, shall be admitted without serving as students, but shall be required to pass the final examinations.

No person shall take or make use of the name or title architect, either singly or in connection with any other word, name, title or designation, nor act as such, either directly or indirectly, unless he is registered as a member of the association.

It is further provided that anyone who, not being registered as a member of the association, takes or makes use of any such name, title, or designation, or acts as architect either directly or indirectly, shall be liable to a fine not exceeding $25 for the first offence, and not exceeding $100 for every subsequent offence, and, in default of immediate payment of the fine and costs, to imprisonment for not more than 90 days, unless such penalty and costs be sooner paid.

Numerous Changes in the Organization and Methods of Ottawa Works Department

Mr. A. F. Macallum, commissioner of works for the city of Ottawa, recently submitted a report to the board of control regarding numerous changes in the organization and methods employed in his department in the five months since he assumed control. Amongst these the introduction of the district system to replace the ward system in street maintenance work is mentioned as being productive of most satisfactory results. Another step was the placing on the foremen of the responsibility for the work done under their supervision. The Commissioner mentions a change which he has made in the previous practice in filling water pipe joints in the city, which he states will effect an immediate saving of over $5,000 and much more in the future. It had been the custom to use all lead in this operation, but in the Gloucester Street 36-inch main he has introduced the use of a backing of oakum, producing a saving of 7 lb. of lead per joint or over $5,000 on the full length of the pipe. A further economy has also been effected by constructing manholes of concrete instead of brick, the cost having been reduced from $42 to $36. A departure was made by introducing the use of lighter base for asphalt pavements on strictly residential streets. On the upper end of Daly Avenue a four-inch instead of a six-inch base was used, with considerable saving in cost. With reference to future changes, Mr. Macallum stated that he would shortly make a recommendation that all street sprinkling be abolished and that all the macadam streets be oiled and all paved streets flushed, as he had found the sprinkling unsatisfactory. Also, it was his intention to use concrete sewers in the place of brick, on account of their cheaper cost.

Relation of Research to Industrial Development

By Mr. Arthur D. Little*

THE railway, as it serves you, is not the casual invention of Stevenson. It is the product of many decades of industrial research by Bessemer, Westinghouse, Pullman; by Dr. Dudley, who standardized its materials and supplies, and by countless chemists, engineers, mathematicians and physicians whose contributions to the common stock of knowledge made possible the development of its equipment, in at least as real a sense as it is the creation of the great organizers, audacious capitalists and wise executives with whom its development is commonly associated in the public mind.

The telegraph as it came from the hands of Morse was a feeble and restricted means of communication. It carries the burden placed upon it by the business world to-day only because it embodies the results of protracted research by Wheatstone, Siemens, Stearns, Edison, Murray and Rowland, which have many times multiplied the working capacity and operating length of telegraph lines.

The telephone, although initially a product of the most refined research, was, when first given to the world by Bell, little more than a scientific curiosity, as halting and uncertain in its speech as a child of three. To-day for the purpose of a conference it brings the people of a continent into one room and even carries the human voice from New York to Honolulu because it has passed through the laboratories of Berliner, Edison, Hughes, Blake, Hennings and Carty, where in each instance new possibilities and powers have been bestowed upon it by intensive and prolonged research. Wonderful and seemingly perfect as the instrument is to-day, the American Telephone and Telegraph Company finds it profitable to authorize its chief engineer, Mr. J. J. Carty, to expend for industrial research a greater sum than any other man in the world has at his disposal for such purpose.

The silent dynamo, instinct with power, supplies the current which lights our streets and homes and factories, drives our machinery, fires electric furnaces, creates new products in electrolytic cells, and is our ready and ever willing servant responding in countless ways to our demands. It so serves us only because Faraday, by refined research, stimulated and directed by the scientific imagination at its best, developed the underlying principles on which its operation depends.

The ocean steamship from wireless to propeller is a microcosm of the results of research without which it would be a scow. The harvester is the embodiment of years of systematic experiment.

What would be the value of corner lots in Winnipeg, of mines in Sudbury, of farms in Saskatchewan, of waterpower on the Shawinigan, of forests in Quebec, of manufacturing plants anywhere in the Dominion, without these aids to industry? Where would your own business be without them? Is it not evident that modern industry is so broadly based and so intimately dependent upon the results of research that in their absence it could not exist a day?

There are in the United States over 250,000 corporations. Over a hundred thousand of them report no net income whatever. Ninety thousand make less than $5,000 a year. Only sixty thousand make $5,000 a year or more. Making all allowances for lack of capital, bad credits, and all the other commonly recognized causes of industrial disaster, I do not hesitate to say without fear of successful contradiction that the chief cause of this amazing and discreditable showing is due to the failure of small manufacturers to utilize that vast body of organized knowledge which the research of the last one hundred years has placed within their reach.

This is merely reiterating what was said years ago by that distinguished Canadian who has done more than anybody else to spread the gospel of industrial research in the United States, Dr. Robert Kennedy Duncan, the founder of the Mellon Institute at Pittsburg. In his "Chemistry of Commerce," Dr. Duncan says: "The small manufacturer who is swept out of existence will often wonder why. He will ascribe it to the economy of large scale operations, or business intrigues, or what not, never knowing that his disaster was due to the application of pure science that the trust organizations and large manufacturers are already beginning to appreciate."

Not long ago a Jewish client brought to us a leather stain for which he is paying 85 cents a gallon. It proved to be water with a little gum tragacanth and still less aniline dye. We showed him how to make it at a cost of less than 10 cents a gallon. He said he began to realize where the Gentiles got the money the Jews got from the Gentiles. In a plant near Boston, using two tons a week of special steel, rolled very thin, their chemist was able, in about two years, to reduce the cost of this material from 80 to 40 cents a pound, while at the same time standardizing and greatly improving the quality of the steel. Broken rails are more expensive than analyses, and there are no dividends in broken trolley wires, defective castings, spotted or tendered piece goods or rejections in any line of manufacture. Competition is difficult when your wastes are your competitor's profit.

At no place in the world are the results of industrial research more strikingly evident than at Niagara Falls. The electrical energy derived from a small fraction of that stupendous flow produces, in its passage through electric furnaces and decomposing cells, aluminum, metallic sodium, carborundum, artificial graphite, chlorine, and caustic soda, perodides, carbide, cyanamid, chlorates, and alundum. The story of the electrochemical development behind these products is an epic of applied science.

Most of the great corporations in the United States have awakened to the commercial value of research. They do not hesitate to spend great sums in the maintenance of superb laboratories and their scientific staff. They expect research to pay dividends, and it does not disappoint them. One American corporation employs 650 chemists.

Research on this great scale is, of course, wholly beyond the means of the average manufacturer, but it is also beyond his requirements. These are well served by such an angency as the Mellon Institute at Pittsburg, or by group laboratories maintained by trade associations or by the higher grade of commercial laboratories which are almost institutional in character. The Royal Canadian Institute has recommended the establishment in Canada of an institution modelled

*Extracts from an address to the Canadian Manufacturers' Association, Dec. 1, 1916

on the Mellon Institute. If the millions of dollars needed for endowment are forthcoming such a step could not fail to greatly stimulate and benefit Canadian industry. The Canadian Manufacturers' Association could hardly spend its revenue to greater advantage than in maintaining for the benefit of its membership a group laboratory along the lines so well laid down by the American Canners' Association, whose laboratory at Washington is devoted to the study of problems which vitally concern the prosperity of the industry as a whole. For manufacturers who desire to have their own specific problems solved there are available several highly organized and well equipped commercial laboratories which specialize in the application of chemistry to industry. The organization which I take pride in representing has come to Canada to serve Canadian manufacturers, to assist in the promotion of industrial research throughout the whole Dominion and to aid you in the survey and development of your amazing natural resources. To this service we bring an excellent equipment, the experience of thirty years and a compelling interest.

A very large proportion of industrial problems are problems in applied chemistry. Many of these so-called problems have already been solved somewhere. The present need of industry is not so urgent for new research and for new facts as for the immediate and proper utilization of facts already known and demonstrated.

In its broader aspects the application of industrial research to the development of the natural resources of the Dominion and the promotion of the welfare and prosperity of its inhabitants holds out a prospect calculated to fire the dullest imagination. In Canada less than ten million people have come into an inheritance as rich in potentialities of wealth as that which has enabled one hundred millions in the United States to take first rank among the great producing nations of the world.

Furthermore, the development of the United States proceeded under the methods, knowledge and financial resources of the 19th century, whereas Canadians in the development of their inheritance have only to reach out and utilize the experience, methods and resources of the 20th century. They have only to study the industrial history of the United States to learn what mistakes to avoid and what good to sieze upon.

In industrial experience and scientific research you Canadians stand to-day a century ahead of the ten million people who one hundred years ago were working out by crude and wasteful methods the industrial development of the United States.

The three factors which, as it seems to me, are essential for the industrial development of Canada are, men, capital, and research. Men may safely be trusted to follow the call of opportunity and probably never will that call sound more clearly than in the ears of those millions in Europe who after the nightmare of this war awake to find themselves heavy-burdened with its paralyzing costs.

The immigration of money is equally needful to your prosperity, but not so easily assured as the immigration of men. There will be plenty of work at home for the pound sterling, the franc and the rouble, and I therefore urge you to devote yourselves to encouraging the immigration of dollars.

The control and expansion of the third factor which I have mentioned as essential, lies wholly within your own hands. Moreover, in proportion as you avail yourselves wisely and generally of the findings of industrial research so will the immigration of men and dollars follow the opportunities thus created. Well directed and protracted research is needed for collecting and correlating the widely scattered information regarding your resources, for demonstrating the value of the specific raw materials which you possess in such profuse abundance, for developing processes for their utilization, and finding new uses, and hence new markets, for the products made from them.

My own organization has, for example, already demonstrated that gasoline in commercial quantities may be extracted from the natural gas in certain fields in Alberta. We have shown that the waste flax straw now burned by your western farmers can be made to yield the highest grade of paper stock, for which there is at present an insistent and general demand. We have undertaken a very comprehensive research to demonstrate the feasibility of utilizing in various lines of industry the enormous tonnage of cereal straws now burned each year upon your prairies.

These things are a mere beginning. They hardly touch the fringe of opportunity. We have, however, entered definitely and seriously upon one phase of the great work in which, through Lord Shaughnessy, we have been privileged to assist. We are now organizing the Natural Resources Survey, which has for its initial purpose the collection, abstracting, classification and correlation of all available information regarding Canadian resources in such form that the essential facts regarding any of them may be almost instantly available to all those in position to use the information to advantage. Any adequate development of the plan involves covering a field so vast and the sifting of a mass of detail so immense that no single organization can expect to cope with it without the nation-wide co-operation of institutions and individuals in position to assist. We shall call confidently upon your association and upon many of you as individuals for this assistance. While this work is begun at the instance of Lord Shaughnessy, and will be carried forward under the auspices of the Canadian Pacific Railway, it is conducted for the benefit of no single corporation, but in the interest of the whole Dominion and of each of you individually as Canadians and manufacturers.

It is the misfortune of the United States that it has no Canadian Pacific Railway to initiate and support, especially in the South, a work of such magnitude and far-reaching benefit. Labor values and brain values constitute the most profitable exports for any country. The export of the brains themselves is an altogether different matter, and the United States lost heavily on the day when Thomas Shaughnessy came to Canada.

The Turbine Equipment Company have obtained a contract from the town of Cornwall, Ont., to supply and install two 10-inch De Laval single-stage pumps, each of which will have a capacity of three and a half million gallons a day against 180 ft. head when operating individually; seven million gallons a day against 180 ft. head when operating in parallel and four and a half million gallons a day against 310 ft. head when connected up in series. This installation is somewhat unique inasmuch as the pumps will be driven by hydraulic turbines; these will be supplied by the Wm. Kennedy Company, of Owen Sound. The speed of these turbines will be 200 r.p.m. and to enable a speed of 1,650 r.p.m. being attained on the pumps a set of De Laval double helical reduction gears will be installed between each turbine and pump.

Buildings of Heavy Timber Mill Construction (Continued)

By C. E. Paul, Construction Engineer

Posts or Columns.

THE posts or columns in mill construction serve as interior supports for the floor and roof girders and carry the load to the foundations. Each set of posts should extend from roof to foundation without offset, passing through each floor between the ends of the girders for that floor, and resting upon a metal cap on the top of the post of the floor below. The ends of posts should be squared and bear evenly upon the plate of the post cap. At the foundation or pier the squared end of the timber post should rest on a metal plate placed on top of the pier a little above the level of the basement floor to prevent contact with dampness from the masonry or concrete. A preservative treatment applied to the ends of the post is advisable if dampness is likely to be present.

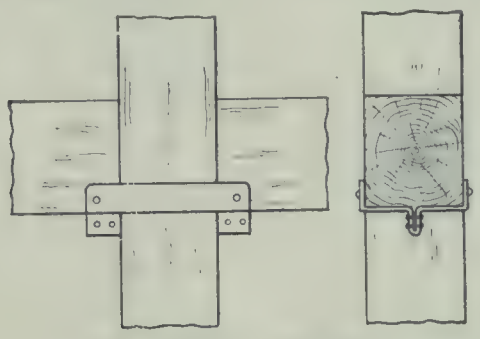


Fig. 8—Steel post cap with fin.

Post Caps and Pintles.

The general alignment of the columns is preserved by the floor and roof girders, which rest upon side brackets projecting outward from the post cap. Figs. 8 to 10 show a few of the types of metal post caps which are in use in different parts of the country.

Fig. 11 shows a type of pintle and post cap which is used to a considerable extent in the New England States, and is recommended by the Associated Mutual Fire Insurance Companies. It should be noted that where no straps are used on the girders, or where post caps without projecting sides are used, the girders are tied together longitudinally by 1 in. iron dogs, placed as shown in Fig. 11. The detail at the roof where this type of construction is used is shown in Fig. 12.

The supporting plate on a post cap should be of such size that the girders will have a bearing of at least 5 lineal inches at each end, and the end of the plate should not extend more than 6 inches beyond the post.

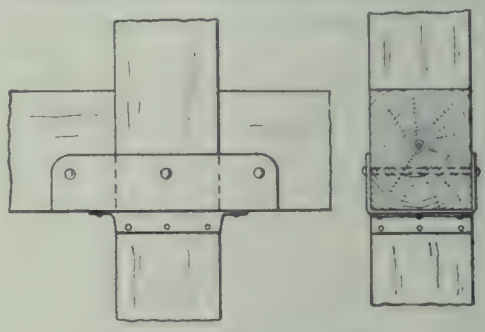


Fig. 9a -A two-way steel post cap.

Minimum sizes of timber for columns vary from 8 inches by 8 inches in top storey to 10 inches by 10 inches in any storey, depending upon the ordinances of different cities. In any event, the area of cross-section should be sufficient to carry the load with a suitable factor of safety, and also provide fire-resisting qualities. Square posts of a given size are nearly one-fourth stronger than a round post turned from the same timber.

Many ordinances, in a measure, control the size of posts by limiting the length of a post of a given side dimension. The Chicago building ordinances state that no timber post shall be longer than thirty times its least side dimension.

Post Details.

While there is a difference of opinion as to the value of boring posts, some insurance engineers recommend the practice of boring a 1½ in. diameter hole longitudinally through the centre of the stick, with ½ in. vent holes at top and bottom. It is claimed that this precaution will prevent damage from dry rot in timber which has not been thoroughly seasoned before using. This should not serve as an excuse for using material fresh from the saw, since it is advisable that none but suitably seasoned timber of the best quality be used in any part of the framing.

Edges of posts should be rounded or chamfered to prevent easy ignition in case of fire. The post should

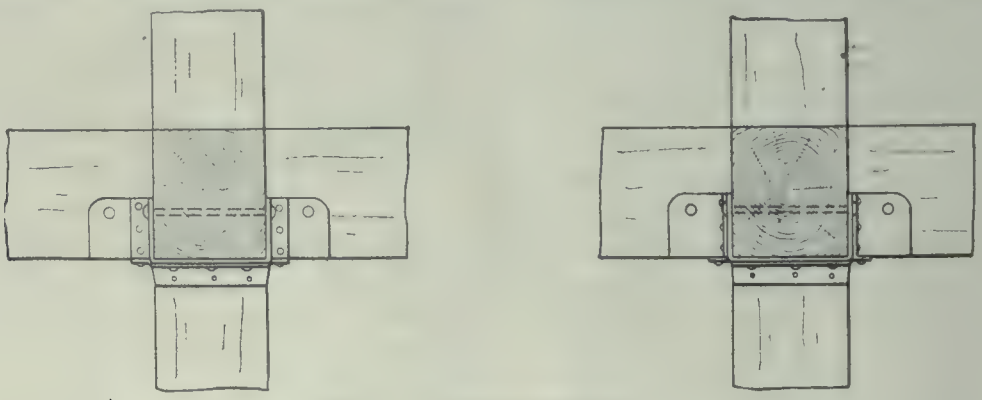


Fig. 9b—A four-way steel post cap.

be left square near top to receive the post cap, and also at the bottom where it passes through the floor.

Finish on Woodwork.

Girders, beams, floors, or posts should not be painted, oiled, or plastered until they have become fully seasoned. This time is usually between two and three years. Wood finish without concealed spaces may be used with safety in offices, etc., but varnish and shellac finishing coats are called objectionable by insurance underwriters. Ordinary paint is not objectionable.

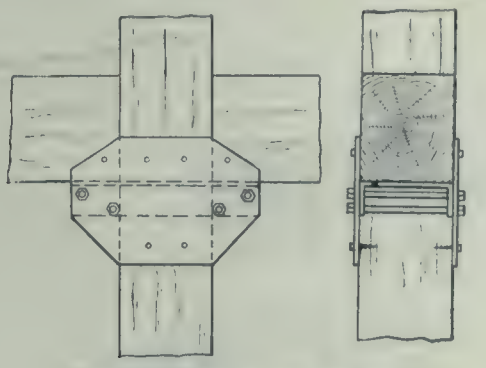


Fig. 10—Steel post cap with side plate.

Roofs.

Roofs in mill construction buildings are usually flat, with a slight pitch of ¼ in. to ¾ in. to the foot. They are framed in the same manner as are the floors, the under side of the roof forming the ceiling for the top storey. If a plastered ceiling is necessary, the metal lath which is to hold the plaster should be fitted around the girders and against the roof boards in such a manner as to leave no spaces between the plaster and wood. If plastering is to be used in contact with the timber it should be of plain lime mortar, without the skim coat of lime putty. The rough plaster is sufficiently porous to permit seasoning to continue if necessary.

Roofs should be covered with an incombustible material. Composition, slag, or gravel roofing is used to a large extent for this purpose.

The necessity of a cornice is questionable, even from an architectural standpoint. It is a constant source of expense for maintenance, and is likely, sooner or later, to become dangerous and fall without warning, due to the failure of concealed members. Providing a cornice is to be used, the open wood type shown in Fig. 13 is recommended by the Associated Factory Mutual Fire Insurance Companies, but an incombustible cornice is advisable when there is exposure from neighboring buildings.

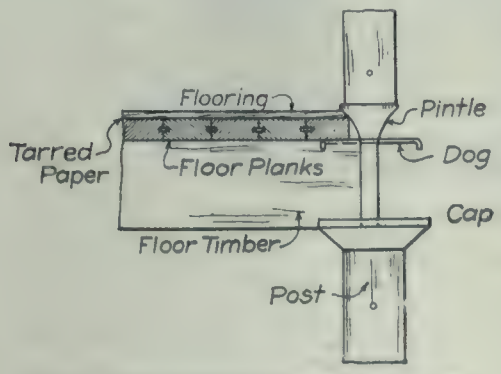


Fig. 11—Pintle and post cap type of construction.

Girders and Roof.

While the size of the girders to support the roof will not need to be as large as those for supporting the floors on account of the lighter loads carried, the minimum sizes of material permitted will control the size of girders to be used. In many cases this dimension is regulated by the local building ordinances, and an inspection of such ordinances will show that sizes vary in different communities. From the standpoint of fire protection, the smallest roof girder that should be used is at least 6 inches in either dimension, but the common building regulation is that such girders should be at least 6 inches thick and have a cross-section area of at least 72 square inches. This same regulation in regard to minimum sizes should apply to beams in semi-mill construction, as well as to the girders in standard construction.

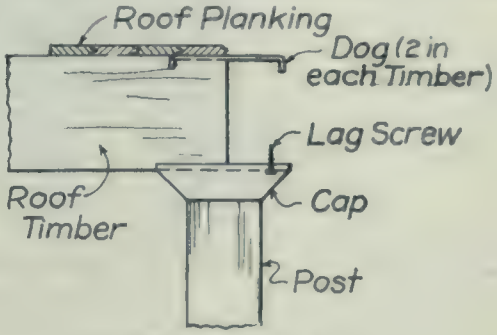


Fig. 12—Framing at roof.

The size of the bays in the roof will be determined by the size of the bays of the floors below.

In many cases a roof of semi-mill construction type is placed on a building in which all of the floors are of standard mill construction or of laminated type. This design is not necessary, since a certain minimum thickness of roof plank is demanded, regardless of the load to be carried, and the thickness of 3 inches commonly specified is sufficient to support ordinary roof loads with the lengths of span between girders commonly found. A simple calculation will show this point to be true, especially where a good grade of lumber is used. Roof plank 3 inches in thickness may be tongued and grooved, but with a thickness of 4 inches and over splined plank should be used.

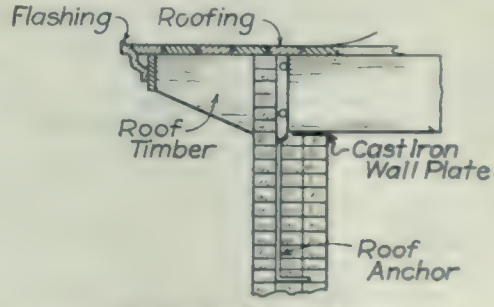


Fig. 13—Detail of wood cornice.

Both roof timbers and planks should be self-releasing at walls and have exposed surfaces planed.

Roof Covering.

One of the most satisfactory types of roofing is of the built-up variety where layers of felt saturated with tar are nailed down and by the use of asphalt or pitch protected and cemented together.

The following specification, quoted from a report of the American Railway Engineering Association, gives what is considered to be good practice in the

construction of a flat built-up roofing on wood sheathing:

Specification for Felt, Pitch, and Gravel or Slag Roofing Over Boards.

Incline.—This specification should not be used where roof incline exceeds three (3) inches to one (1) foot (modern practice tends to reduce this slope to 2 inches to 1 foot). For steeper inclines modified specifications are required.

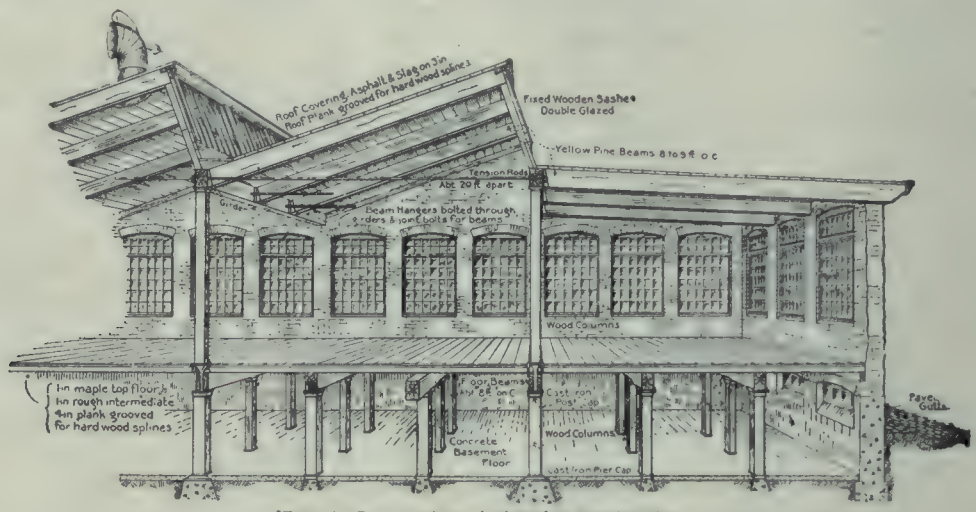


Fig. 14—Saw-tooth roof of timber construction.

Specifications.

Roofing.—First, lay one (1) thickness of sheathing paper or unsaturated felt weighing not less than five (5) pounds per hundred (100) square feet, lapping the sheets at least one (1) inch.

Second, lay two (2) plies of tarred felt, weighing fourteen (14)) to sixteen (16) pounds per hundred (100) square feet, lapping each sheet seventeen (17) inches over the preceding one, and nail as often as is necessary to hold in place until remaining felt is laid.

Third, coat the entire surface uniformly with straight run coal-tar pitch.

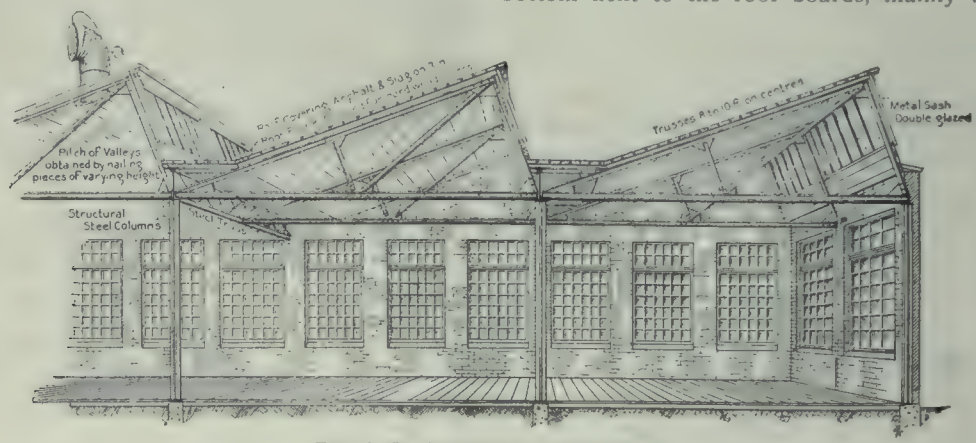


Fig. 15—Steel framing with plank roof.

Fourth, lay three (3) plies of tarred felt, lapping each sheet twenty-two (22) inches over the preceding one, mopping with pitch the full twenty-two (22) inches on each sheet so that in no place shall felt touch felt. Such nailing as is necessary shall be done so that all nails will be covered by not less than two (2) plies of felt.

Fifth, spread over the entire surface a uniform coating of pitch, into which, while hot, imbed not less than four hundred (400) pounds of gravel or three hundred (300) pounds of slag to each one hundred (100) square feet. The gravel, or slag, shall be from one-quarter (¼) to five-eights (⅝) inches in size, dry, and free from dirt.

Flashings.—Flashings shall be constructed as shown in detailed drawings.

Labels.—All felt and pitch shall bear the manufacturer's label.

Inspection.—The roof may be inspected before the gravel or slag is applied by cutting a slit not less than three (3) feet long at right angles to the way the felt is laid.

N. B.—To comply with the above specifications, the material necessary for each one hundred (100) square feet of roof is approximately as follows: 100 square feet sheathing paper, 80 to 90 pounds tarred felt, 120 to 160 pounds straight run coal-tar pitch, 400 pounds gravel, or 300 pounds slag.

In estimating felt the average weight is practically fifteen (15) pounds per one hundred (100) square feet, and about ten (10) per cent. extra is required for laps.

In estimating pitch the weather conditions and expertness of the workmen will affect the amount necessary for the moppings and to properly bed gravel or slag.

The sheathing paper or unsaturated felt is placed on the bottom next to the roof boards, mainly to keep any pitch which might penetrate the two-ply felt above it from cementing the roofing to the sheathing. It also is of value in preventing the drying out of the roof through open joints from below. The saturated felts should be nailed where there is any chance of disturbance of the roof from underneath by wind, and also enough to hold it in place while laying. The practice in regard to nailing varies in different parts of the country, but the fewer nails the better, so long as the roof is held in place.

The contract price for this roof should not be less than the cost of the materials specified, plus the cost of laying and a reasonable amount for profit. Thor-

ough inspection of materials and workmanship is recommended.

Trussed Roofs.

In many types of commercial buildings open spaces without posts are desired. This condition is very likely to exist in manufacturing plants where large areas of clear floor are necessary for the movement of machinery or assembling machine parts. In such buildings the posts are taken out and roof trusses used to span the opening. Trusses are ordinarily placed from 8 feet to 20 feet on centres, with 3 inch plank spanning the distance between the trusses as in standard mill roofs, or resting on purlins spaced not less than 8 feet on centres and running from truss to truss. It is advisable to have the purlins supported at the joints of the trusses to prevent bending in the members of the top chord. Other details of the roof are similar to those described above.

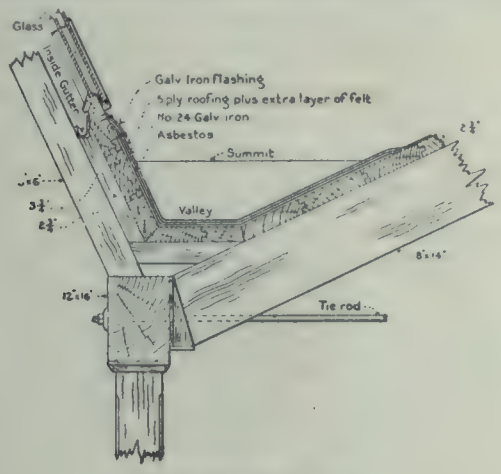


Fig. 16—Detail of valley.

Saw-Tooth Roofs.

Where a saw-tooth form of roof is needed the roof planks are supported by heavy timber beams, or by steel trusses, spaced from 8 feet to 10 feet on centres, and in turn carried by timber girders, trusses, or columns. In fact, the design of the roof planking itself varies but little from that used in the ordinary flat roof of standard mill construction. The detail of the supporting member will vary with the type used. Figs. 14 and 15 show two forms of saw-tooth roofs, one wholly of timber construction and the other of timber and steel. Fig. 16 shows a detail of the valley used in timber construction, such as shown in Fig. 14. These details are as recommended by the Boston Manufacturers Mutual Fire Insurance Company.

Fire Protection.

A building can be protected from damage by fire from exterior sources by the use of fire-resisting shutters or wire glass in steel or hollow metal frames at the windows and openings, together with an incombustible cornice. Thick party walls, and parapet walls extending not less than 3 feet above the roof line, form additional safeguards. Fires occurring within a building may be confined to a limited space by the use of fire walls, heavy timber floors without openings, enclosed stairways, automatic fire doors, protected openings into power and elevator shafts, protected windows near angles of the building, and incombustible interior walls which extend through the roof for a distance of 3 feet or over. The installation of an automatic sprinkler system of a design capable of reaching fire in any part of the building and supplying water in sufficient quantities is always advisable. Not only does such equipment serve as a protection from spread of fire, but it allows also a lower insurance rating on the building and contents. A dependable water supply is a necessity, and at least two independent sources are generally provided from gravity tanks, pressure tanks, pumps, or high pressure street service.

Standpipes and hose located in stair towers or other protected places offer additional safety. A steamer connection on exterior of building is advisable.

Details in regard to the design of sprinkler systems and the arrangement of other protective apparatus are covered by a special bulletin issued by the National Lumber Manufacturers Association.

Stairways and Elevator Shafts.

Vertical openings through buildings have proved to be the weakness which led to the destruction of many otherwise good buildings. All doors and openings into stairways or elevator shafts and between units should be provided with fire doors. These doors should be made automatically self-closing by means of springs or weights and chain. Doors should never be blocked open, even temporarily. Where it is necessary to allow a door into a stairway to stand open it should be held by some simple automatic mechanism, arranged to release the door and allow it to close when fire occurs. Stairs may be of timber construction if the building is equipped with an automatic sprinkler system and stairways are enclosed by fireproof walls.

Shutters and Wire Glass.

For severe or dangerous exposures it is desirable that all openings in exterior walls should be protected by tin clad, solid steel, or sheet-metal shutters. Shutters should overlap the sides and top of the window opening or close into the opening, so as to prevent cracks through which fire might pass. Modern practice has determined that steel or hollow metal wire glass windows are substantial in construction and practical under most conditions of exposure. Such windows furnish a fair degree of resistance to fire, and where the exposure is not severe, they will prevent the spread of fire from one building to another, or one story to another in the same building. Two types of windows are commonly used—"steel sash," made of rolled steel sections, and hollow metal sash and frames, made of galvanized sheet metal or copper of suitable gauge, reinforced by steel bars and angles. Wire glass is used in both of these types.

The fire-resisting qualities of mill construction are exemplified by the following extract from "Fire Prevention and Fire Protection," by J. K. Freitag:

"A wonderful illustration of the slow-burning qualities of slow-burning construction was afforded by the fire which destroyed the storage warehouse of the George Irish Paper Corporation, at Buffalo, N.Y., January 16, 1911. The building was six storeys in height, 70 by 200 feet in area, and of mill construction, without sprinklers or other special fire protection equipment. Because of the type of construction of the building, and the great weight of the paper stock known to be stored therein, the firemen flatly refused to enter the structure, so that the flames were fought merely from the outside. The fire raged for upwards of 80 hours and was the longest fire known in the City of Buffalo, yet, after 36 hours of fire, the front windows in the top storey were practically intact. No better example of 'slow-burning' construction could possibly be given."

(To be continued)

Union station under erection at False Creek, Vancouver.

New Union Station, False Creek, Vancouver

To be occupied by the Northern Pacific and Great Northern Railway Companies on or about April 1, 1917

THE picture shown herewith scarcely does justice to the present appearance of the new Great Northern Railway depot on False Creek, Vancouver. Since it was taken the foreground has been cleaned up and the various sub-contractors handling the interior work have made such progress that Engineer Ford, of the Great Northern Railway, is hopeful that some of the offices will be ready for occupancy early in the new year, although the freight sheds, trackage, etc., will probably not be completed much before April 1st, or one year from the date of starting of construction. An average of 174 men has been maintained on the works, in addition to a grading force of about 140 men.

The building is of reinforced concrete, faced with pressed brick and trimmed with terra cotta. It is situated 375 feet east of Main Street and just north of the Main Street Bridge. The building is L-shaped in plan, the main structure approximately 60 feet wide and 230 feet long, facing Main Street. The centre portion is two storeys high and contains the main waiting room, which runs the full height and is some 60 feet wide by 100 feet long, flanked by wings on either side approximately 65 feet long and 50 feet wide, two storeys in height. On the second floor of these wings are located the offices of the Northern Pacific and Great Northern, the latter company using the station jointly with the Northern Pacific.

The leg of the L is one storey in height, running in an easterly direction, and here are located the baggage room, mail room, Great Northern and Northern express, trainmen's room, etc. East of this in a direct line is located the power house, where heat is supplied to the main building through an underground tunnel. Two 125 h.p. boilers are installed, the capacity being ample for the operation of a private lighting plant, should this be decided upon.

Work is now in progress on two freight sheds, 600 x 50 feet, of the clear span type. They are of brick construction, with steel roller doors, occupying practically the entire length on both sides. At either end are two-storey brick office buildings.

Track-laying in connection with the depot system has been under way for the past month or more. Altogether there will be over nine miles of roadbed. Seven lines will be laid in the depot itself, provision being made for eleven. There will be six freight house tracks, one industrial track, and eleven coach tracks, where trains will go for refitting purposes after discharging passengers.

Early in the new year a start will be made on a brick engine house, (15 stalls), machine shop, storehouse and fuel station. These will be built to the rear of the east side of the station, on ground that is now being filled in and graded.

Prosperous Year for Moncton, N. B.

The past year has been a most prosperous one for Moncton, N.B., as shown by statistics of trade and general progress. All the local industries report a larger output than last year. The figures covering the building permits issued show a total of $192,230. This is one of the highest years of which there is record. The totals for 1914 and 1915 are larger, but these are unusually high on account of the fact that they included three new churches, the city hall and the new Aberdeen school, all rebuilt to replace structures destroyed by fire. Both the Aberdeen school and city hall and market were completed this year, the former costing $110,000 and the latter $75,000. The new Central Methodist Church, a stone structure costing $100,000, was also completed this year.

Wider Approach for Toronto-Hamilton Road

The Toronto-Hamilton Highway Commission have laid before the Toronto Board of Control their proposal to build an 86-foot roadway as an approach to the city instead of one only 18 feet wide. It was decided that the engineer of the Highway Commission, Mr. H. S. Van Scoyoc, Harbor Commission engineer E. L. Cousins, Commissioner of Works Harris and the Finance Commissioner, get a report ready and confer with Mr. Gooderham before anything further is done.

Amendments to the Quebec Lien Law

MATTERS of importance to contractors and supply houses of Quebec Province are considered in "An Act to amend the Civil Code with reference to privileges of workmen, builders and other persons," introduced by Mr. Taschereau, Minister of Public Works of the province. Conditions under which contract work has been carried out are claimed, under the present act, as equally unsatisfactory to the contractor and to the proprietor.

A committee of the Montreal Builders' Exchange, consisting of Messrs. W. C. Munn, convenor, J. P. Anglin, A. W. Bremner, Robt. F. Dykes, and J. Quinlan, president of the Exchange, have considered this bill and express the opinion that the time is too short for its proper study and so counsel delay until next season. Failing this, they have drawn up a list of suggested amendments—the results of their own personal experience as to the requirements of the case. In addition Mr. Quinlan has given out the following statement to the Contract Record:—

I take it that when the Legislature enacted this law it was for the purpose of enabling those desiring to erect a home for themselves, who had no other collateral, to secure a builder to undertake the work, knowing that the land would be security for the cost of the improvements made to it. It was also intended that the land and improvements should be security for wages of workmen employed thereon, for the sub-contractor and for the supplier of materials. Thus, it would appear that workmen, architects, contractors, sub-contractors and suppliers of materials were engaged in a business where there was little chance of loss through the failure of proprietor or contractor, and that the law was a real benefit to the building industry and the public.

We find, however, that in the actual working out of this law, there are so many strings to it that to comply with all the requirements of the Act would simply tie most building contracts into a knot; so much so, that many specifications and contracts compel architects, workmen, contractors and suppliers of materials to sign off their rights before the work is started.

Let me take the case of a house costing, say, $20,000. The contractor, on receiving such a contract, if he is consulting his own interests, makes contracts for the delivery of most of his materials, as well as for the sub-contracts for work he does not intend to perform himself, immediately he receives his contract. Now the law requires that in order for the sub-contractor and the supplier of materials to benefit by its protection, it is necessary to notify the proprietor before the delivery of said materials; and in case of the sub-contractors, previous to executing their contracts. Thus, in a good many cases the proprietor finds himself responsible for the payment of most of the materials and workmanship to others than the general contractors with whom he made his contract. The result is that if the proprietor takes the advice of his lawyer, he simply withholds from the general contractor the full amount of the different liens before they are due or the work performed. The general contractor finds himself in this position: he has made a contract with the proprietor to erect a building for the sum of, say, $20,000, payments to be made as follows: 85 per cent. of the value of the work payable each month as the work progresses, and the balance thirty days after the final completion of the building. In good faith he goes ahead with his first month's work and completes the foundations, and spends, say, $3,000. The architect issues a certificate for that amount, less 15 per cent., which the contractor presents to the proprietor for payment. The proprietor looks up his books and finds that there is some ten thousand dollars worth of privileges registered against the contractor, for work that has not yet been done, and for materials not supplied. He tells the contractor that he is advised by his lawyer not to pay the general contractor anything until these claims have been satisfied, in which case the general contractor has to be in a position to finance at least one-half of the cost of said building or arrange with his sub-contractor and supply men to forego their protection. In most cases the sub-contractor and supply men find that they have committed themselves by preparing this work to such an extent that it is better to forego their privileges and take the chance of the general contractor paying them than to sacrifice what work they have already done; thus, if the contractor fails, they lose their money.

Again, the law has been so unpracticable that it is seldom taken advantage of; in other words, it is the exception rather than the rule. In this way, when the proprietor is notified, he refers the notice to the architect, who immediately becomes suspicious of the contractor. The contractor's standing in the eyes of the proprietor and the architect suffers, and if he does not cancel the orders given he holds this against the supply men and sub-contractors, and if possible avoids doing business with them in future. Again, all supply men and workmen are not familiar with the details of the law, and give more credit than they otherwise would if the law did not exist.

So far, I have only considered ourselves as builders and suppliers of materials, but we must also consider the proprietor's and the public's side of the case. I am ready to admit that if this law would work out in practice as it is framed, the proprietor and the public would have more call for complaint than we contractors and suppliers of materials now have. I do not pretend to be sufficiently learned in the law to understand in full the details of this Act, but it appears to me that if this law were taken advantage of by unscrupulous or insolvent contractors, the proprietor might have more cause for complaint than the contractors and supply men now have.

Looking at it from the point of view of a proprietor, I certainly think that when a proprietor undertakes to erect a building he is taking some chances. What is to prevent a contractor from taking a building contract at a low price and doing the work that is profitable to him first, getting his 85 per cent. of money and allowing his sub-contractors to register liens greater than the total amount of the contract price which the proprietor agreed to pay?

It seems to me that in order to frame a satisfactory act, full protection should be given the proprietor as well as the builder, and for this reason I think a proprietor should not be held responsible for the full payment of materials and workmanship without

Imposing buildings may be made with granite-faced cast stone blocks—Two residences showing their use either for the entire house or as a trim.

being afforded the opportunity of protecting himself. Of course, there is always the opportunity for the proprietor to insist on the contractor furnishing a bond guaranteeing that the work will be carried out as per contract, and thereby protecting himself, but apart from this, I think in all fairness the proprietor should get equal protection from the Act. I would suggest that the proprietor should be held responsible for 15 per cent. of the amount of the contract until thirty days after the final completion of the building without any registration whatever, and that suppliers of materials be given thirty days after the delivery of such materials in which time to register their claim; that sub-contractors be allowed one month's work to be done without registration; that they be given fifteen days to register if this first month's payment is not made, and this fifteen days shall apply to any month's work that has not been paid for during the execution of the contract, and that all workmen be extended the same privilege, only that workmen should have a preference over sub-contractors, contractors, and suppliers of materials in the case of failure of the proprietor.

Thus, I would expect the Act to work out as follows: that the proprietor and the builder be held to the extent of 15 per cent. of the total amount of the contract price up until thirty days after completion, without registration, and in addition to this all the unpaid claims which have been registered according to the Act. This would enable the proprietor to see that the general contractor was paying his workmen, sub-contractors and suppliers of materials at least monthly, thereby protecting himself, but I would not recommend that he be held for more than the total amount of the contract price, providing that he had complied with the Act in making his payments.

A Water Supply Proposed for Islington and Lambton Mills, Ont.

The plan of a water system to supply Islington and Lambton Mills, Ont., was submitted and explained by Engineer E. A. James at a recent meeting of the Islington Town Improvement Society. Engineer James stated that after investigating various sources he had decided that Chaffee and Darling Creeks would be the most suitable. The water from both had been analyzed, he said, and found to be 98 to 99 per cent. pure. This would entirely eliminate the expense of a filter system. The creeks are from three-quarters of a mile to one mile distant from Islington. A pumping station would be erected near Darling Creek, a short distance west of the Humber River, and also west of the local side road in order to avoid any dirt from the highway. It would be at an elevation of 332 feet. A trunk feeder would run just west of the side road from Chaffee Creek to the pumphouse. According to the proposed plans, a reservoir for both districts would be built 215 feet above Lake Ontario and 170 feet above Islington. It would be 30 feet in diameter and 24 feet deep, and would exert a pressure of 80 lbs. to the square inch. There would be seven miles of mains, and the water could be pumped and delivered at from 8 to 10 cents per thousand gallons. This proposed system, according to Engineer James, would serve a population of 7,000, while there are about half that number or less living in the area included. The cost was estimated at between $60,000 and $80,000, including the pumps and mains. The whole scheme will be submitted to the township of Etobicoke Council at its next session.

Granite-faced Concrete Blocks Have Useful Possibilities

On the opposite page are illustrated two buildings in which granite-faced building blocks, known to the trade as cast stone blocks, are used. These are made by machinery manufactured by the Cast Stone Block & Machine Company, Windsor, Ont. Of all building materials granite stands first in beauty and permanence, and were it not for its exceeding hardness, which makes it expensive to cut and work into convenient sizes and shapes, granite would be a much more generally used material for building purposes than it is. As the Cast Stone blocks have only a thin facing of granite, it is possible to procure this building material in all its natural sparkling beauty at a cost not exceeding that of the ordinary sand-faced blocks. It may also be procured in all sizes and shapes for any building purpose whatever.

Ever since block-making began manufacturers have continually experimented with facing cement blocks in an attractive manner. This company appear to have succeeded beyond all others in producing not only a perfect cement building block, but one which also possesses the beauty and the quality of solid granite. These blocks cannot be said to be an imitation product, but are in actual fact a cement block veneered with pure granite, possessing the strength, the appearance, and the hardness of solid granite.

During the last two or three years many buildings have been constructed of Cast Stone blocks alone or of brick with block trim, and many handsome homes, schools, and other public buildings indicate the growing popularity and the permanence of this building material. One of the fields of big possibilities which it opens up is as a base for stucco work. This is partly due to the fact that cement block construction for stucco necessitates the use of absolutely waterproof blocks. With a surface unexcelled for plastering these blocks are claimed to offer a better base for stucco work than any other material that has been used to date. The hollow air chambers prevent cold from penetrating to the interior. Being moisture-proof and durable, these blocks make a stronger and better building. Another reason is that the ratio of expansion and contraction of cast cement blocks is the same as cement stucco, which prevents the stucco from cracking and peeling off.

The bearing strength of these blocks is attested to by the Department of Applied Mechanics in the Faculty of Applied Science of the University of Toronto. Some months ago Professor Peter Gillespie, of that department, made a test on a piece consisting of 12 blocks of normal dimensions, 12 in. x 16 in. in plan and 8 in. high. These blocks were laid up in a neat cement mortar, and were tested at an age of 30 days, the jointing being six days old. A neat cement was used in order that at the anticipated time of testing its strength would be comparable with that of any ordinary mortar at the age of a month. The report states that the pier failed by vertical cracking in the plane of its 16 in. dimension at a load of 93,300 pounds. Since the net area of the pier was 114 square inches, this was equivalent to a load of 820 pounds per square inch. In addition to the great strength of this material, the illustrations show the handsome and massive appearance given to the buildings in which it is used. Granite-faced window and door sills and lintels can also be supplied to the contractor.

The town of Amherst, N. S., has under consideration the installation of a motor-driven centrifugal pump in connection with the waterworks system

Extensive Harbor Works for Vancouver

THE Vancouver Harbor Commissioners have recently made public a comprehensive scheme for the development of extensive harbor works. This includes the $5,000,000 project of which mention has previously been made, and a plan, known as Scheme No. 7, which was drawn up by Mr. A. D. Swan, M.Inst.C.E., M.Inst.M.E., M.Can.Soc.C.E., who visited Vancouver in 1912, a year before the Harbor Commission was incorporated, under instructions from the Dominion Government to report on the port and its needs for development both for immediate and future requirements. Mr. Swan's plan is complementary to the $5,000,000 scheme, and brings the total proposed expenditure up to $21,000,000. The combined schemes include the development of both sides of the harbor, the reclamation at False Creek, the linking up of the Granville Street mud flats and the provision of ocean terminals at the Indian Reserve. The plan provides accommodation for 21 large modern steamers, basins dredged to 35 feet below water, and foundations at six berths to allow for 40 feet below low water if hereafter required, a grain elevator with a capacity of 2,000,000 bushels or more, and a large area of land for development of industrial business, erection of warehouses, and oil storage tanks. The entrance provided to the various basins under the scheme is said to be excellent. The railway accommodation is also very good, and in proportion to the berthing accommodation, according to a statement made by Commissioner McClay, of the Harbor Commission, while a large area of land is available on the Kitsilano Indian Reserve for warehouses and other industrial development. Of the amount to be expended on the project, $5,000,000 is for the construction of two-storey reinforced concrete wharf sheds of the best construction. The width of the two principal piers under the proposed plan is 300 feet. The ultimate width, however, will be decided on in accordance with the results of the borings.

Commissioner McClay draws particular attention to the very excellent site which would be available on the Kitsilano Indian Reserve ground for a large grain elevator in connection with the complete scheme of development near this point. If a grain elevator were constructed somewhere near the proposed wharves there is, he states, ample accommodation for future extension of the elevator itself and a vast amount of room for railway sidings, for storage and quick handling of grain traffic; and by a system of conveyors this one elevator could serve for shipping grain at every one of the 21 berths most expeditiously.

As regards the necessary expenditure, the Commissioner states that while the amount may seem to some people to be too large, in the nature of the plan a contract to provide accommodation for, say, eight or ten steamers could be proceeded with first, and the remainder could follow by degrees as commerce and trade increased and the necessities of the situation demanded greater facilities.

Mr. Swan, the designer of the plan, recommended in his report that "wharf areas, railway terminals, roads, elevators and freight handling facilities in general should be designed on the most liberal scale practicable and constructed by degrees." In a lengthy list of summaries he also advised that additional wharfage should be provided along the waterfront from the C. P. R. pier and that additional wharfage should be provided east and west of the B. C. Sugar Refinery plant. He recommended the widening of the Narrows (now almost completed), and the filling in of the upper end of False Creek east of Main Street, and that it should be used as a central railway terminal for all railways whose lines may end in Vancouver. The natural position to construct deep water wharves was, in his opinion, as near to the centre of the city as circumstances would permit. As regards the type of construction, he urged that concrete and reinforced concrete should be adopted. In concluding, Mr. Swan advised most strongly that the harbor of Vancouver should be controlled by one board of administrators, under whose management he had no hesitation in predicting it would rapidly develop into its natural position as one of the greatest shipping ports in the world.

Toronto Works Department Has Curtailed Operations

In his report to the Toronto board of control for the past eleven months, ending November 30, Commissioner R. C. Harris stated that during that period the operations of the Works Department were greatly curtailed as compared with those for the same period last year. In the roadway section, 205,100 square yards, or 14.45 miles, have been paved, as compared with 462,641 square yards, or 32 miles, in 1915. Of this, 4.6 miles were paved with asphalt and 2.6 with concrete. Nearly 7 miles of concrete sidewalks were laid. Three old macadam roadways, 2.1 miles, were resurfaced at an expenditure of $3,712.97. In addition $10,759.80 was spent on repairs to other macadam roadways. The expenditures on all work done by the department during the year amounted to $5,554,192, as against $9,563,430 in 1915.

The enlargement of the Ontario Highways Act to permit the government to give a larger measure of assistance to counties undertaking road construction in districts near cities is receiving the consideration of the Highways Department. Under the Act as it stands at present the government undertakes to pay forty per cent. of the cost of construction on county highways up to a maximum specified amount per mile. A deputation from Wentworth County recently petitioned that this limit of expenditure per mile be removed and that the government pay forty per cent. of the total cost on an improved type of highway, approved by the Highways Department.

Personals

Mr. John Dickie, a Fort William contractor, recently enlisted with the 230th Forestry Battalion. Mr. Dickie came from Scotland to Fort William, where he has lived for a number of years.

Mr. P. J. Phelan has been appointed supervisor of bridges and buildings for the Grand Trunk Railway Company, and Mr. W. J. Tyers supervisor of bridges and buildings, Belleville division.

Gordon Mitchell, Lymon Pringle, and S. Barnes, of Hamilton, and H. Rose, of Guelph, four Toronto University boys,

who went overseas last March, have been graduated from the School of Military Engineering at Chatham, England, and granted commissions in the Royal Engineers.

Mr. B. H. Phillips has been appointed secretary-treasurer of the Montreal Machinery and Supplies, Limited, recently organized for the supply of contractors' machinery and plant for munitions manufacturers. The office is at McGill Building, Montreal. Mr. Phillips was formerly connected with the Montreal Ammunition Company and the National Bridge Company.

The Hamilton Board of Control have recommended to the incoming council for their favorable consideration the appointment of the following civic officials: E. R. Gray, city engineer; A. P. Kappele, works manager; and James Bain, mechanical superintendent. Messrs. Gray and Kappele have been acting in these capacities since Mr. Macallum left the employ of the city to go to Ottawa.

Obituary

Mr. George Howlett, a resident of Sharon, who has been engaged in the carpenter trade, died recently from pneumonia. The late Mr. Howlett, with his brother, had been prominent in building and contracting work in York County, Ont.

Mainly Constructional

East and West—From Coast to Coast

The New Ontario Contracting Company, Limited, Port Arthur, Ont., have obtained a charter.

The Canadian Association of Master Painters and Decorators recently held their thirteenth annual convention in Toronto. December 12 to 14.

The Strassburg Art Stone, Marble and Granite Company, Ltd., has been incorporated, with a capital of $5,000; head office at Strassburg, Sask.

Tenders have been called for the purchase of the plant of the Crushed Stone Company, Limited, Deschaillons, Que., which has gone into liquidation.

The council of Wentworth County and the Hamilton city authorities contemplate joining hands in a comprehensive highway scheme for the district.

The Nickson Construction Company, Ltd., has been incorporated, with a capital of $25,000; head office at Vancouver, B.C. The firm will carry on the business of general contractors.

Negotiations which the Vulcan Iron Works have been carrying on with the city of New Westminster, B.C., to secure a suitable site for their contemplated extension, have failed. As a result the firm is moving to Vancouver and will, it is believed, locate on the north shore of Burrard Inlet.

The Hull Steel Foundries, Limited, contemplate an increase in their output by making considerable extensions to their plant at Hull, Que., including the installation of blast furnaces for smelting the ore from the Gatineau district. This furnace installation represents an expenditure of over $500,000.

According to present indications in Hamilton, Ont., there is likely to be a fair amount of work for contractors and builders during this winter. At the present time upwards of 200 buildings of various kinds are in course of construction throughout the city, many of which have only recently been started.

The British Pacific Iron and Steel Company proposes to expend some quarter of a million dollars on a steel plant near Eburne, B.C., on the Fraser River, where they have secured a ten-acre site. Orders have already been placed in the East for several open-hearth furnaces. Pig iron will be secured from China.

It is encouraging to note the rapid manner in which Blind River, Ont., has been built up again since its partial devastation by fire. On Woodward Avenue, both sides of which were destroyed by the conflagration, handsome brick and concrete buildings have been erected to take the place of the old frame structures burned.

Various improvements are contemplated at the plant of the Dominion Steel Corporation at Sydney. The changes are intended to increase the annual output as well as to decrease the cost of steel productions. Mr. Workman, the president, announces that the company does not owe a cent, and that the outlook for the future was never brighter.

The Canadian Milk Products, Limited, have purchased the factory of the Hickson Cheese and Butter Manufacturing Company, Hickson, Ont., and are going to remodel and convert it into a modern mik powder plant. The McKinney Lumber Company, Woodstock, have the general contract for the remodeling of the old plant and the building of new additions. The work will cost $60,000.

Hon. Finlay Macdiarmid assured an Ottawa deputation recently that the government had no intention of blocking construction of the proposed Ottawa-Prescott highway. The municipalities interested in the scheme have been hearing rumors that work was not to go on until after the war, and the deputation came to Toronto to get an understanding of the situation and to object to any such delay.

Permits for factories to the value of $2,000,000 have been issued in the city of Toronto this year, as compared with only $331,497 last year. The value of the dwellings will, it is expected, be about the same as last year, when they reached $2,102,530. The big Union Station permit, amounting to $2,800,000, issued recently, will bring the total value up to nearly $10,000,000, or about $4,000,000 more than 1915.

Organization work in connection with the trunk road to connect Ottawa with Pembroke and Petawawa is continuing. A conference was recently held at Renfrew of delegates from all localities so far organized. There still remain a few townships not yet co-operating in the scheme, and arrangements have been made to complete the work of organization; also for an address by Mr. W. A. McLean, Deputy Minister of Highways.

The Dominion Iron and Wrecking Company, Quebec, have secured the plant of the Standard Steel Foundries at Outremont, Que., and that of the Consolidated Brass Foundries at Pointe au Tremble. It is the intention to consolidate these large plants and engage in the manufacture of munitions. New equipment is to be installed, including 15 electric furnaces of the newest type at the Consolidated Brass plant.

The Bricklayers', Stonemasons', and Plasterers' International Union held their thirteenth annual provincial convention at Ottawa, Ont., recently, where a hearty welcome was extended to the delegates by Ottawa trade unionists and representatives from the city. Mr. John Cameron, president of the Allied Trades and Labor Council, was in the chair. One of the most important matters discussed was the erection of safer scaffolds, and it was urged that the newer box scaffolds be used, which are provided with a roof nine feet from the floor, which prevents anything falling from above. The following officers were elected: President, John McLeod, Toronto; first vice-president, N. W. Beaver, Ottawa; second vice-president, George Egerton, Galt; third vice-president, A. E. Greenlaw, St. Catharines; secretary-treasurer, Walter Thorne, Toronto.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Aylmer, Ont.
The Waterworks Board contemplate the installation of two gas engines. Clerk, D. C. Davis.

Carleton County, Ont.
The County Council propose to submit a by-law to authorize the macadamizing of certain roads, at an approximate cost of $5,000. Clerk, Charles MacNab, County Court House, Ottawa.

Cayuga, Ont.
Tenders may be called shortly for the construction of a watermain and installation of a steel tank, pump, gas engine, hydrants, valves, etc. Material for the work will be purchased by the committee in charge. Estimated cost, $4,000. Engineers, Jackson & Lee, Temple Building, Brantford.

Dundas, Ont.
The Town Council will submit a by-law to authorize the borrowing of $55,995 for the construction of trunk sewers and connections with a sanitary sewer system and sewage disposal works. Clerk, J. S. Fry.

Kent County, Ont.
The County Council are considering improvements to about 200 miles of roads. Clerk, Jonas Gosnell, Chatham.

Leamington, Ont.
The Town Council have been petitioned for extensions to the watermains. Clerk, R. M. Selkirk.

Listowel, Ont.
The Town Council contemplate the construction of reinforced concrete pavement on Main and Wallace Streets and will submit a by-law in January. Clerk, William Bright. Approximate cost, $18,000.

Middlesex County, Ont.
The Provincial Government, the County Council and the City of London are jointly considering improvements to about sixty miles of road around the city. Approximate cost, $150,000.

Ottawa, Ont.
The Canadian Pacific Railway Company propose to pave the approaches of the Interprovincial Bridge with wood block, and will start work in the spring. About 3,000 square yards will be laid.

St. Catharines, Ont.
The following estimates for the construction of a sewage system in the Facer Street district have been submitted to the City Council by Engineer W. P. Near: Sanitary sewers, $23,900; storm sewers, $27,000; pump plant, $7,000; disposal works, $18,000.

The Pas, Man.
The Dominion and Provincial Departments of Public Works are jointly considering the construction of about eleven miles of road, at an approximate cost of $10,000. H. Gordon, C.E., The Pas, is interested in the project.

Thorold, Ont.
Tenders on the supply of a turbine pump and electric motor will be received until noon, December 30th, by the Waterworks Superintendent, L. S. O'Connor. Specifications with the superintendent.

Trail, B.C.
The City Council are considering the construction of waterworks and sewage systems, and will have plans prepared by Engineer A. L. McCulloch, Nelson, B.C.

Victoria, B.C.
The Dominion Government propose to construct a watermain from the William Head Quarantine Station to the City's Sooke Lake main. Estimated cost, $125,000.

CONTRACTS AWARDED

Sandwich, Ont.
The Town Council have let the contract for construction of a watermain and sewer on Centre Street to Merlo. Merlo & Ray, 296 Windermere Road, Walkerville, at $43,579.

Railroads, Bridges and Wharves

Baysville-Gravenhurst, Ont.
The construction of an electric railway from Baysville to Gravenhurst is being considered by the Hydro-Electric Power Commision of Ontario, University Avenue, Toronto, and the municipalities concerned. Engineer, M. Bucke, care of the Commission.

Bridgeburg-Welland, Ont.
The construction of a radial line between Welland and Bridgeburg is being considered jointly by the Provincial Government and the municipalities concerned, and a by-law will be submitted. The road will not be built until after the war.

Brighton Beach, Ont.
The Mullen Coal Company contemplate the construction of a dock, about 600 feet long.

Fredericton, N.B.
Tenders will be received until noon, December 27th, by the Department of Public Works, Fredericton, for the lumber required in the construction of the Fredericton Highway Bridge and for the Woodstock Highway Bridge. Specifications for both bridges at the Department, and for the Woodstock bridge only with D. W. Jackson, Highway Superintendent, Upper Wodstock, N.B.

Kamloops, B.C.
The Canadian Northern Pacific Railway propose to build a bridge between Kamloops and Kamloops Indian Reserve No. 1, and have submitted the plans to the Minister of Public Works, Ottawa.

Matane, Que.
The Canada and Gulf Terminal Railway propose to construct a railroad extension to the Gaspe Basin, a distance of about 250 miles. General superintendent, J. E. Pinault, Matane.

Ortonville, N.B.
The Provincial Department of Public Works propose to build a bridge over the St. John River. Plans will be prepared during the winter and tenders called in the spring.

Port Arthur, Ont.
The Dominion Government Department of Public Works, Ottawa, propose to build an addition to the breakwater, at an estimated cost of $1,500,000. Secretary, R. C. Desrochers.

Preston, Ont.
Tenders on the steel work required in the erection of a bridge and subway on King Street will be called about April. The concrete abutments and retaining walls will be constructed by day labor. Town Engineer, C. S. McKenzie.

Renfrew, Ont.
The Grand Trunk Railway Company propose to construct a siding into the premises of the International Molybdenum Concentrator, at an approximate cost of $3,000. Work will start immediately.

Winnipeg, Man.
Brown & Rutherford, Sutherland and Buchanan Streets, propose to construct a wharf at the Parish of St. John, on the Red River, and have filed plans at the Winnipeg Land Titles Office.

CONTRACTS AWARDED.

Lanark County, Ont.
The contract for steel work for McIlquham Bridge No. 1 has ben let to the Ontario Bridge Company, Ltd., Crown Office Building, Toronto, at $8,400. County Clerk, W. A. Moore, Perth, Ont.

Vancouver, B.C.
The general contract for the construction of an extension to the Canadian Pacific Railway Company's Pier "D" has been let to S. E. Junkins & Co., Room 309 C.P.R. Station, Vancouver. The piles are to be supplied by the Vancouver Creosoting Company, Ltd., Standard Bank Building, who are now receiving tenders on approximately 300,000 lineal feet of green piles. General contractors are receiving tenders on hoisting machines and air equipment, and will shortly take tenders on roofing, lumber, bolts, etc.

Public Buildings, Churches and Schools

Dundas, Ont.
The Board of Education are considering the erection of a high school, and will submit a by-law to authorize the purchase of a site. Secretary, W. H. Moss.

Montreal, Que.
Bigonesse & Bigonesse, 60 Notre Dame East, are preparing plans of a school. Stone, reinforced concrete, hollow tile, and brick construction.

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Exchanging Equipment on a Rental Basis

IN this column we recently commented upon the decision of the Montreal Builders' Exchange to deduce a plan for exchanging on a rental basis, the surplus plant of contractors. The advantages of a scheme of this nature in solving some of the complexities pertaining to present methods are very evident. The prevalent dullness of building, with the consequent tying-up of vast amounts of capital in machinery and equipment, has added weight to the idea of what might be called a clearing house for contractors' plants. The mutual benefits that would accrue would make an exchange proposition worth while and the obviation of enforced idleness would mean a depreciation account with some operating results to offset it, rather than the writing off of large percentages with nothing to show.

To the small contractor, for whom the carrying of a large plant would prove an unnecessary and irksome burden, a pooling of equipment would be a boon that would enable him to operate profitably and economically.

The Montreal Builders' Exchange has been especially active in fostering the scheme, and we believe the matter might well be taken up by other interests.. The special committee which the Exchange appointed to consider the value of the project and to draw up details of its operation has just reported on the subject. The formation of a permanent bureau is recommended, the commission to the Exchange for renting or sale of plant being fixed at 5 per cent. The secretary is to obtain a standard rental or sale form to be used on all transactions. Members of the Exchange are asked to send in lists of their plant which they are willing to rent or sell, these lists or changes to be submitted monthly. When the lists are completed a standard charge for various pieces of machinery will be arranged and listed so that there will be uniformity in this respect. All matters or questions arising in this connection or any disputes are to be settled by a standing committee appointed to supervise the operations of the bureau, and their decision must be binding on the members concerned.

The value of this agreement must be judged from the results, but there can be little doubt that the operations will prove justifiable and pave the way for other builders' organizations to follow.

More especially does the suggestion appeal to us at this time, when the matter of conservation is the basic principle of our national organization. National service, if it be service, must obviate wasted efforts. There is a call for mobilization of resources, and every form of industry, from the country's greatest manufacturing establishment, to the humblest contracting business, must be made to fit in with a general scheme of things that is to result in extracting the fullest co-operation from the facilities at hand. The formation of a clearing house opens the way for a better appreciation of the necessity of concentrating our resources on the needs of state and of placing our facilities at the disposal of others who may need them, in this way economizing in both material and money.

The Importance of Town Planning

MR. Thomas Adams, town planning advisor to the Conservation Commission, addressed the members of the Montreal Builders' Exchange at a luncheon held on December 14. One of the main points emphasized was the necessity for arteries in any town planning scheme. It would, said Mr. Adams, be futile to lay out a scheme for, say, Montreal, without taking into consideration the question of arteries leading off the main highways or boulevards. More attention to light and air is necessary, while it is also desirable to consider the possibility of cheapening building, in order that the artisan class may the more readily build or purchase their own houses. One advantage of a town planning scheme is that it conduces to beautiful surroundings, thus attracting population and inducing men with artistic tastes and with an appreciation of healthful and comfortable environments to settle in a town. For these reasons Mr. Adams urged the Builders' Exchange to support the proposed town planning Bill for the Province of Quebec. Mr. James Ballantyne, of Montreal West; Alderman Shephard, of Westmount; Mr. A. Chausse, building inspector of Montreal; Mr. Ewing, of the C. P. R., and Mr. J. P. Anglin, spoke in support of this measure. Mr. Chausse pointed out the necessity for a comprehensive building code for Montreal; at present, owing to the annexation of outlying municipalities, different codes were in force, naturally

making for confusion in the building by-laws. Mr. Ewing advocated the allocation of a given district for the concentration of all factories, which in Montreal, as in other places, would mean economy in the matter of transportation.

The Clay Products Convention

The Canadian National Clay Products Association will meet in convention in the Royal Connaught Hotel, Hamilton, on January 23, 24, 25, 1917. A very attractive entertainment programme has been provided in addition to comprehensive list of papers and addresses to be presented by prominent members of this association. There will also be papers by well-known clay products men from the United States. The following list will give a general idea of the matters to be discussed:—

Clays in the vicinity of Hamilton, by Joseph Keele, B.Sc., chief engineer, Ceramics Dept., Mines Branch, Ottawa.

Labor-saving devices in soft mud brick yards (illustrated), by J. F. Aten, of the Arnold-Creger Company, New London, Ohio.

The practical application of pyrometers to the burning of wares, by J. P. Goheen, of the Brown Instrument Company, Philadelphia, Pa.

Soft mud brick, by W. H. Freeborn, Brantford.

Burning by pyrometers versus burning by guess, by James De Von, of the Thwing Instrument Company, Toronto.

Clay products and standardizing their use, by E. H. Darling, Hamilton.

Technical education, by George L. Sprague, Principal of the Hamilton Technical and Arts School.

Success in a one-horse tile yard, by John T. Miner, Kingsville, Ont.

Burning tile with natural gas, Aaron Hill, Essex, Ont.

Burning clay ware in producer gas fired kilns, by A. F. Greaves-Walker.

An illustrated talk will also be given by Jack Miner on "The value and intelligence of our birds." Mr. Loomis, of Sherbrooke, has also promised to be present and address the meeting. Mr. A. F. Greaves-Walker will conduct the question box.

Civic Improvements at Brockville, Ont.

In the report of the Works Committee of Brockville, Ont., to the city council, a number of interesting items are mentioned. In the matter of garbage collection, a reduction was made in the number of collectors engaged in the work through a readjustment of the routes covered, with a consequent saving in expense, but without decrease in efficiency. The only permanent pavement constructed this year was on Court House Avenue, where vitrified brick was laid, the wire-cut lug (hillside) type being used. This pavement was constructed in accordance with the latest specifications and consisted of a Portland cement concrete base and cement sand bed, instead of the sand and brick grouted with cement grout. The concrete curb for the centre boulevards was all reinforced, adding materially to the strength and eliminating contraction cracks to a great extent. Work has been started on tarvia roadways on Bethune Street from the St. Lawrence River to Pearl Street, the necessary storm drains having been put in, together with nearly all the necessary catch basins. Granolithic sidewalks have been constructed on Brock Street and Bartholomew Street, the approximate length being 1,450 feet. A sanitary sewer was constructed on Pine Street, from Garden Street to a point about 165 feet westerly, and a sanitary sewer and storm drain are now under construction on Emma Street.

The system of sewerage and storm drains for the north eastern section of the town, north of the Grand Trunk Railway tracks, which was under construction at the close of last year, was completed. This system consists of sanitary and storm sewers on Ormond Street from Sophia Street to Central Avenue; sanitary sewer on Sophia Street, from Ormond Street to Park Street, and a sanitary sewer on Park Street to Charles Street. In addition to the above work there was also constructed in connection with this system, an inverted syphon to carry the sewage under Butler's Creek, a concrete collecting tank and pump well with wooden superstructure; in the pump well there are two motor-driven direct connected vertical centrifugal pumps, operated by float switches. These pumps lift the sewage from the collecting tank through a 6-inch cast iron force main to the manhole at the corner of Charles and Park Streets, at which point it flows into the Park Street Sewer. In connection with this system there was laid 1,745 lineal feet of 6-inch tile sewer, 2,398 lineal feet of 9-inch tile sewer, 360 lineal feet of 12-inch tile sewer, and 890 feet of 6-inch cast iron pipe. The total length of sewers under construction at the end of last year and completed this year, together with those completed this year, amount to a total of 2,800 lineal feet.

The Annual Meeting of the Manitoba Branch, C.S.C.E.

At the annual meeting of the Manitoba Branch of the Canadian Society of Civil Engineers, which was held on Thursday evening, December 7th, the following officers were elected for next year:—Chairman, W. L. Mackenzie; secretary-treasurer, A. W. Smith; executive committee, J. C. Holden, H. W. McLeod, and M. V. Sauer; auditors, T. L. Roberts and B. S. McKenzie; committee on Papers and Discussions, E. T. Spidy, G. L. Guy, and D. L. McLean; committee on Research and Investigation, E. Brydone-Jack, J. A. Douglas, and T. L. Roberts; committee on Library and Trade Publications, J. C. Holden, M. C. Hendry, and J. A. Heaman.

Prof. M. A. Parker was the speaker of the evening, and gave a paper on "Air Pollution," which was most interesting. Although Winnipeg is relatively free from the smoke nuisance, the speaker advised his hearers to take warning from the amount of smoke in some cities and not let Winnipeg become blackened in a similar way if this district becomes the manufacturing centre that is hoped for by her citizens. Enormous quantities of smoke are vomited forth on London, Pittsburgh, and other cities, and if we are to prevent such a tendency in Winnipeg the speaker felt that very serious consideration would have to be given to the subject.

It is officially announced that Canadian Vickers, Limited, are enlarging their shipbuilding plant at Maisonneuve, P. Q., by adding a berth 500 x 128 and another 400 x 100 feet. This will provide for the construction of vessels of 12,000 tons. The company have considerably added to the original plant, and are now very busy on war and general shipping orders.

The Ottawa River Storage Scheme

What Has Already Been Done Towards a Conservation of the Power Resources of the Ottawa Watersheds—Engineering and Contracting Features

FROM a recent report of the Minister of Public Works, on the Ottawa River Storage, covering the year 1915, we are reproducing a number of illustrations showing the dams that have been built to provide storage basins in the upper Ottawa watershed. This storage scheme had its inception some years ago in connection with a maintained flow of water for the Chaudiere powers at Ottawa. The Chaudiere fall is the only one of a number on the Ottawa river that is used for the development of power and at certain times of the year a shortage of water was experienced that interfered considerably with the power output. The tributaries of the Ottawa river which supply the water discharge rapidly, leaving but little ground water in their watersheds for the summer's supply. To make provision for the development of power, not only at the Chaudiere fall at Ottawa, but at other points, some time in the future, the scheme of providing storage basins was projected and actively pushed between 1904 and 1908, when construction was decided upon.

The first idea was to build eight or ten dams of comparatively low height at the outlets of various lakes; they were to be of wooden cribwork, similar to those built throughout the country by lumbermen, with weirs closed by stoplogs. Extended investigation, however, showed that better results would be obtained by confining the work to the three large lakes, Quinze-Expanse, Timiskaming and Kipawa, each over 100 square miles in area, and into which large watersheds drained.

It was therefore decided to build concrete structures of considerable height and secure as deep storage as possible upon each of these three lakes. The raised surface for these reservoirs was sharply limited by damage to property which was rapidly increasing in value owing to the exploitation of Cobalt and other mining areas.

The Three Dams

The accompanying map illustrates the location of the various elements of this scheme. The Timiskaming dam was begun in May, 1909, and completed August, 1912. The cost will be nearly $500,000. The total length of dam is 1,600 feet, the height 25 feet, and the flood flow through sluice-ways 100,000 cubic feet per second, several times more than through the Assuan dam, Egypt. To avoid excessive inundation, arrangements were made to deepen and widen the outlet of the lake, and thus tap lower layers of the reservoir.

The Kipawa river dam at the north end of Kipawa lake, was begun November, 1910, and completed May, 1911, at a cost of $62,000. The Gordon Creek dam at the south end of the lake was begun October, 1911, and completed May, 1912, at a cost of $42,000. Land damages are roughly estimated at $6,000, and the total expenditure will be $110,000. In 1911, the partial storage given off from Kipawa reservoir helped to avoid the recurrence of extreme low water and consequent trouble with the domestic supply at Ottawa city.

Work on the Quinze dam was begun August, 1911. It was finished in October, 1914, but no storage was available for that autumn. Damages to timber limits by flooding are difficult to estimate, but the 23,000 acres affected may be placed at $70,000, and the total cost would then be about $500,000 for this reserve. The dam is a rock-fill, over a mile long, with sixteen regulating sluices capable of passing flood flow.

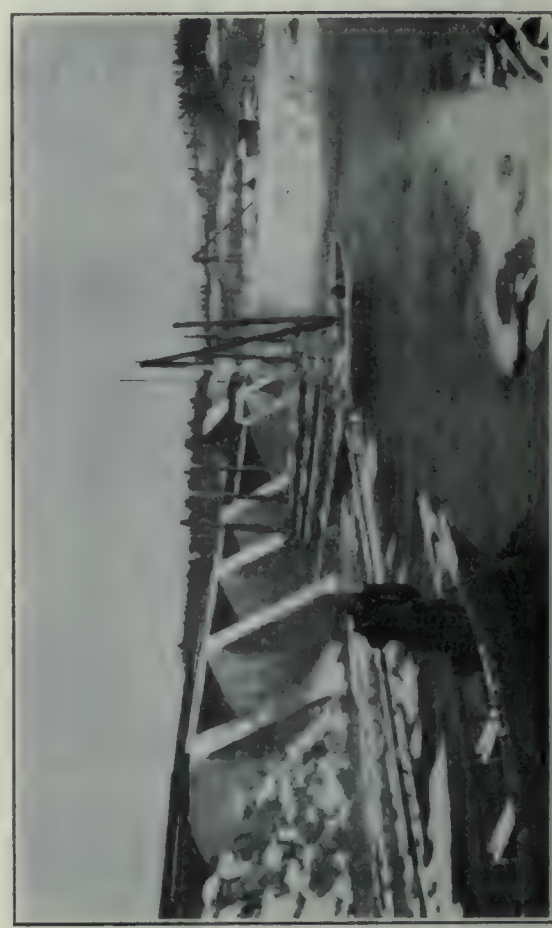
The total cost of all dams is estimated at $1,100,000.

Results of Storage

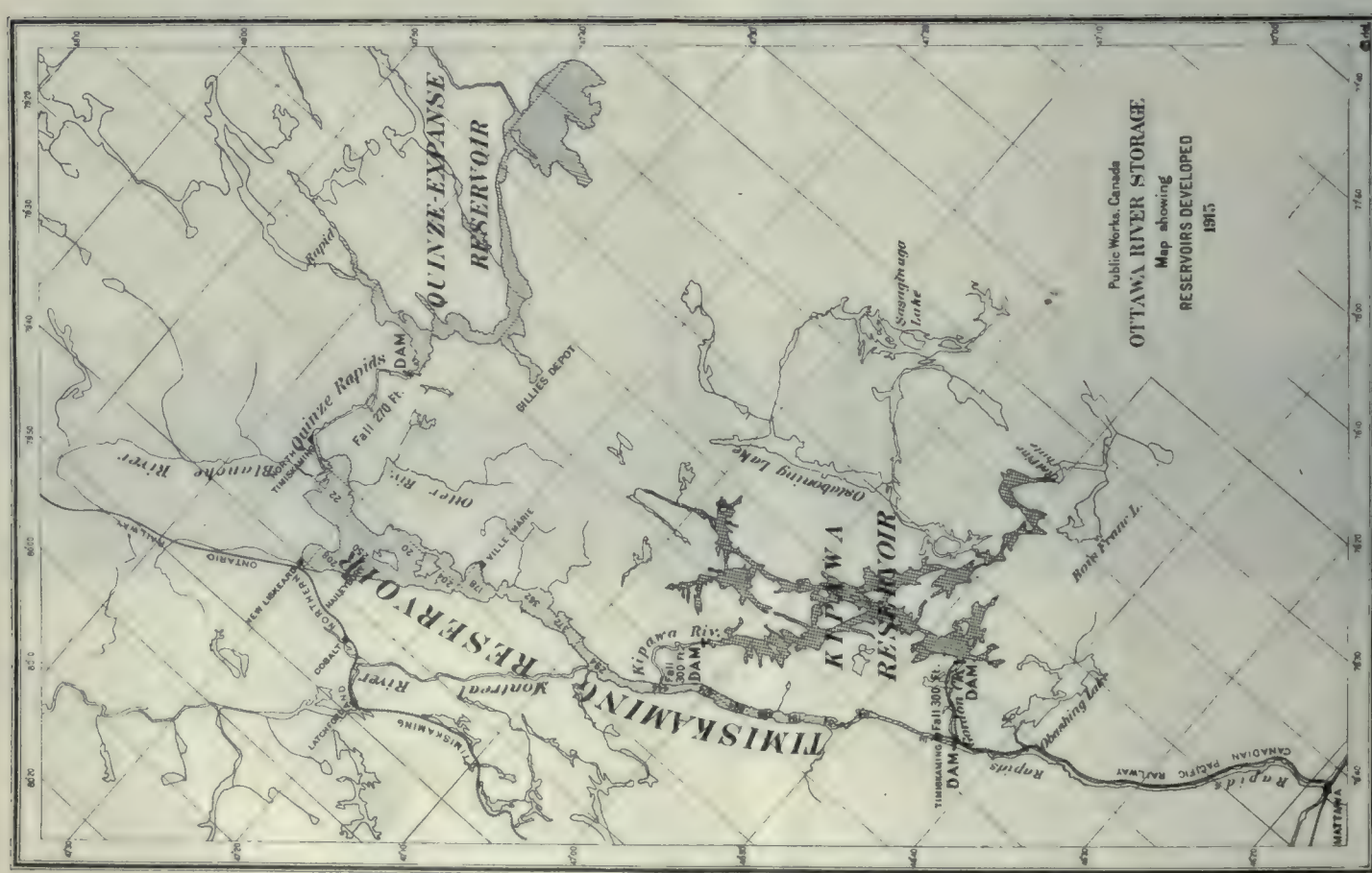
Although the results are still very incomplete, the efficiency of the storage reservoir has already indicated itself. In April, 1913, the spring break-up was very early, with the result that the Madawaska and other south tributaries of the Ottawa discharged rapidly, leaving but little ground water in their wastersheds for the summer's supply. The ensuing rainfall was very scant, in fact the period from April to September, inclusive, showed only 14 inches precipitation, the lowest since 1906. Timiskaming reservoir filled quickly

The Quinze dam, a part of the Ottawa storage scheme, showing concrete sluiceways and log pass with rock-fill at right. This structure was so located as to be built without cofferdam, and the water raised after its completion

A general view of the Timiskaming dam, showing the Ontario sluices in the foreground



The Timiskaming reservoir, Quebec sluices; crib-work being placed along downstream side to protect against scouring



and remained full with surplus water running out until the end of June, from which time it was necessary to draw steadily on the storage till the middle of October, when 7 feet had been taken off, and navigation interests began to complain.

Kipawa reservoir was also drawn down about 7 feet when navigation was affected in a peculiar manner, as the raised level had allowed of going into bays formerly never approached, but to which access now became a vested right. There was also difficulty in loading steamboats from the wharfs when the surface lowered 7 feet.

The benefits of storage were shown by an increased navigation depth on both Kipawa and Timiskaming. At points lower down the river also, there was a foot or more better depth than in former dry years.

Greater Flow Over Falls

The second series of benefits consisted of the increased amounts of water passing over the various falls along the Ottawa river. At present only the Chaudiere fall at Ottawa is developed, and when the flow is less than 20,000 c.f.s., the various powers experience shortage, but at 30,000 c.f.s., all have sufficient water, labor is constantly employed, and the municipal requirements for light and transportation are easily met.

In 1913, the flow at Ottawa diminished to 20,000 c.f.s. about the middle of August, but instead of falling below this it was maintained at about that figure till autumn. This, too, although the autumn rains were delayed till the end of October, after which there was an abundant supply during January, February, and March, 1914.

The Timiskaming Reservoir

The detailed description of Timiskaming reservoir will be taken up first. It consists of the lake of that name, which has an area of over 100 square miles and is navigable for steamboats for 70 miles from Timiskaming station, Canadian Pacific Railway, to North Timiskaming. This lake is a rift in the granite plateau filled by the Ottawa river through the Quinze rapids and emptying through another rapid portion of the Ottawa extending 38 miles from Timiskaming to Mattawa.

Upon this reservoir area 15 feet in depth of an available storage is held by the Timiskaming dam consisting of 20-odd weirs with concrete piers between, each weir being closed as desired with stoplogs. The storage can easily be accumulated from the 8,000 square miles of drainage area above and the 11,000 square miles of local basin.

The concrete weirs at the outlet were begun in May, 1909, and the dam was put into operation August, 1912. The total length of the dam is 1,600 feet with 20-odd regulating weirs capable of discharging a flood flow of 100,000 c.f.s. A small island in the middle of this river at the location of the dam provides two channels, the east one being the Quebec channel and the west one the Ontario channel. In each a dam was built.

Winter Difficulties

The construction of the Quebec channel dam, during the winter of 1912, was hampered by an unremitting fight against water during very cold weather. Anchor ice formed in quantity at the mouth of Gordon creek, 300 feet down stream from the dam, and the penned-up water threatened to overtop the lower cofferdam. The coal supply for steam machines was constantly running low and the pumps and other machinery became frozen despite constant care.

The filling of the cut-off trench with concrete was a very serious undertaking, especially in its western half, where the water-saturated sand caved in to an alarming extent. After the sluices had been completed and as much riprap as possible was laid along each shore as a protection against the current, the cofferdam was then blown out both above and below the work as far as the rapidly rising water admitted.

To avoid excessive inundation of property and still obtain a great volume of storage water, the design contemplated the widening and deepening of Timiskaming outlet.

About 4,000,000 pieces of timber, mostly sawlogs and pulp wood float past Timiskaming every year, so a timber pass with heavy booms forming a funnel approach was constructed and has given satisfaction.

Log-Lifting Machine

For removing and placing the stoplogs in the sluiceways a lifting machine consisting of two 40-foot spuds with rack attachment was set up. It is driven by a 10-h.p. Dake steam engine connected by gearing to pinions that mesh into the spud racks. The log-lifting machine has given fair satisfaction, but an accident during a rise twisted one spud, a 9 by 9 I-beam, and the dam was without lifting machine for several days. Hand winches, which are held in reserve, sufficed to take out enough stop-logs to pass the flood, but the surface stood nearly a foot above regulated level for some days. The engagement of the lifting spud with the lower stoplogs when a heavy current is passing through the sluiceway presents constant dangers and difficulties.

A new lifting apparatus capable of raising all the logs fastened together as one gate has been designed, and detail structural plans prepared. The cost would approach $50,000, so its construction has been deferred for the present.

Several attempts have been made to remove parts of the cofferdam with explosives, but although the wooden cribwork is easily blown apart, there is little effect upon the stone filling. The dredge was brought down but was unable to remove the material, owing to the strong current.

Wash-outs on Timiskaming Dam

A very serious wash-out below the Ontario sluiceways of Timiskaming was discovered in July, 1913, after the spring freshet had subsided. On the 25th of April, a critical examination was made below the dam, but no scour of any consequence had then taken place. Between April and July, however, the lower apron, a concrete slab 1 foot thick, extending 400 feet across the channel and 50 feet downstream, was broken up and carried away for a length of 200 feet. The river bottom was scoured out 20 feet below grade for a distance of about 100 feet, and at 200 feet the erosion was fully 5 feet deep.

Why the river bottom was not scoured out during the two previous summers, that this part of the dam had been in operation is impossible to say. No excavation was done during the past two years downstream, but the channel upstream was enlarged during the last summer and many larger boulders were loosened by the steam shovel. Possibly the strong current of the spring freshet may have carried boulders bouncing through the sluices, which cracked the lower apron. On the other hand, the vertical back swirl, due to the heavy sheet of water, may have broken through the hardpan layer and washed out the sand and gravel beneath.

To make repairs, it was necessary to first place all

Timiskaming reservoir, Quebec sluices; washout repaired by rock-fill embankment. Slight leakage through rock is seen along toe

Quinze dam; view of upstream face across river, showing sluiceways and rock slope staunched with fine material. Full reservoir surface will be five feet below the top of the dam

The Timiskaming reservoir, Ontario sluices; lifting machine with spuds up ready to lower and grapple a stoplog. Beneath the white water 20 ft. in depth of rock has been deposited to fill in the scouring of the river bed

Timiskaming reservoir, Quebec sluices; washout, June, 1914, fifteen feet deep when four sluiceways were destroyed. Temporary suspension bridge 100 feet long, also locomotive crane depositing rock in gap, are shown

the stoplogs in the Ontario sluiceways and then to staunch them tight with plank sheeting and canvas curtains. A quarry was then opened near the Ontario end of the dam, and the broken rock was deposited in the scoured-out portion of the river bed.

The scour also extended underneath the concrete floors of the sluiceways, and this had to be filled with concrete deposited through water 10 to 20 feet in depth. Every precaution was taken against leakage to prevent currents that might wash away the cement. The concrete was deposited through a tremie, and the mixture was made very wet, so it would flow as far as possible into the cavity.

On June 14th, 1914, a wash-out occurred beneath the island end of the Quebec sluices at Timiskaming dam, and a hole 15 feet deep was scoured in the river bottom. Three of the concrete piers dropped down, completely wrecking four sluiceways, or about 100 feet in all of the dam.

It was decided to sacrifice the four sluice openings and fill the break with a loose-rock embankment to the full height and width of the roadway. It is allowable to close these openings because the provision has always been found very ample, and the completion of Quinze dam now admits of controlling and lessening the peak of the spring floods.

The cause of this wash-out will always remain uncertain, but a leak, or piping, as it is called, must have occurred through the treacherous soil either beneath the piers or in rear of island abutment.

The Quinze Reservoir

Quinze reservoir consists of lakes Expanse and Quinze, navigable for 60 miles, and totaling 120 square miles in area, upon which a depth of 20 feet can eventually be stored. The watershed area tributary to this reservoir is about 8,000 square miles.

The dam is a rock-fill, over a mile long, with sixteen regulating sluices, situated about the central part, closed with stoplogs, and capable of passing the flood flow. It was located and designed in 1910, and the foundation of the sluiceways was completed in March, 1912. Owing to the condition of the summer roads, little could be done on the completion of the concrete sluiceways and the rock work, but operations commenced in September, 1912. Some clearing and grubbing was done and the excavation of a bank seat trench commenced on the north side of the river. During the winter of 1913, British Columbia fir stoplogs were hauled into the work; also sufficient cement to build the concrete sluiceways.

The gravel for concrete work was obtained from the pit previously opened for the foundation concrete. The cement was much fresher than that used the year previously in foundations, but it was found that the concrete was again very slow in setting. In consequence, the gravel was washed, with improved, but not altogether satisfactory results, as to rapidity of set. Pipes were then arranged to spray water continuously upon the piers, and after a time a thoroughly good monolith was obtained.

Cause of Slow Setting

It has since been found that this slow setting was due to some brown gravel distributed in layers through the pit, which contains chlorates of magnesium and potassium, that tend to retard the set. The only method of overcoming this difficulty is selection in the gravel pit, if possible, accompanied by very thorough washing.

When a rock-fill is built upon the natural surface of the river shore, the seepage issuing along the toe, with the reservoir full might undermine the foundation. After consideration it was decided to excavate a trench to good material along the downstream toe, which will be filled with the loose rock of the dam. The seepage is thus carried away through this large stone drain without scouring the earth beneath the fill.

The Quinze dam, showing the down-stream face of rock-fill embankment and bed of river laid dry

The work was largely rock excavation from borrow pits, which has been deposited in the rock-fill dam, but some further excavation was done to obtain foundations for sluiceway piers.

During construction there was considerable settlement of the embankment into the soft swamp which, of course, has increased the quantity of rock used. Staunching material of earth and gravel has been deposited upon the upstream slope all along the embankment. The rock-fill dam was extended into the river from both the north and south sides, the central portion averaged nearly 40 feet in height.

Altogether 113,600 cubic yards of rock were excavated from the borrow pits and the sluice foundations, all of which was deposited in the fill except 4,500 cubic yards used for concrete. The rock excavation was done by coyote blasts, that is, a small tunnel was driven in 20 or 30 feet, a T chamber made at the end and loaded with powder and dynamite. Much of the rock, in pieces up to a cubic yard and over, was hauled a quarter of a mile on stone boats sliding on wooden poles. The central portion was hauled from the north side borrow pits by narrow-gauge cars into which the rock was lifted by Forest loaders. These are small horse-power derricks that have proved very useful, both at Quinze and at Timiskaming.

Joint Drainage Works Permitted

Under a Bill of the Quebec Government, power is given to two or more municipalities to perform jointly certain drainage works, provided that the geographical situation is favorable. The investigation will be made by the Superior Board of Health, who, with the municipalities, may apply to the Quebec Public Utilities Commission. The latter will make inquiries, and determine the nature of the work to be done, give the necessary order for it, fix the time and method in which it is to be executed, and apportion the cost and manner of payment.

Experiences in Water Filtration

Rapid Sand Filters and Accessories — Coagulation—Controlling, Operating and Indicating Devices—Layout and Operation of Plant

By Mr. H. G. Hunter, Mem. C.S.C.E.*

Rapid sand filters is a generic term, implying two essential types of filters, the gravity and the pressure. The gravity filter is one wherein the water is passed through the filtering medium by the force of gravity. Such filters are contained in open tanks, and the raw water always passes through a coagulating period before reaching the filter. The pressure filter is enclosed in a steel tank, and operates under pressure. The arrangement of the underdraining systems is quite similar in both types of filters, and each has a bed of filtering material of about the same kind and depth of sand. The chief difference is as before stated, in that one operates under pressure and the other by gravity. The pressure filter requires less space than the gravity filter, and is particularly applicable in certain cases where it is desired to avoid double pumping of the water, the filter then forming a part of the continuous piping system between the raw water pumps and the distribution system.

The gravity filter is of far wider usage, since it appears to be somewhat better suited to all around conditions; but it must not be forgotten that there are numerous cases where the pressure filter will prove distinctly better.

Preparatory Treatment of Water for Filtration.

In preparing raw water for gravity filtration it is always essential that it first be freed of a substantial percentage of the impurities it contains in order not to unnecessarily overload the filter, and thus unnecessarily decrease its reserve capacity and increase the cost of its operation. This preparatory treatment may be effected by long storage, whereby the suspended matters are separated out of the water by sedimentation, or by coagulation and sedimentation, in relatively small basins. The latter procedure is the one most commonly followed, since its effect is quicker and far more thorough and its cost far less.

In the preparatory treatment last mentioned an iron or aluminum salt is used as a coagulant, and sometimes a mixed salt of these two bases.

In Canada sulphate of alumina is used chiefly. The action which is brought about by adding the aluminum salt to water, was discovered thousands of years ago in China, and results in the release in the water of a flocculent, neutral hydrate of aluminum, which attracts and enmeshes the suspended and coloring matters in the water, including the bacteria, and thus forms relatively large aggregates, which settle out rapidly in basins designed for that purpose. Such of the coagulated matter as passes the coagulating and settling basin is strained out by the filters, and a clear and colorless filtered water results.

The basins in which the raw water is prepared for filtration are of various types. Some are rectangular in plan, some square, some circular, their shape and size depending chiefly upon the character and volume of the water to be treated and sometimes upon the topographical conditions met with.

The design embodies well known and essential features. First the basin is divided into two compartments, so that one half may be cleaned while the other is in use. It is important that the water enter the basin evenly throughout its width, and we find that to deliver the water at or near the surface is good practice. The effluent should be taken from near the surface and evenly over the width of the basin. In a straight-flow basin it is not found that baffles are necessary, other than that it is well to arrange to stop a "short cut" surface flow with a baffle near the inlet end.

In other basins where baffles are used, sudden and violent fluctuations in velocity of flow are avoided so far as possible, in order to prevent the breaking up of the forming coagula. Baffles are advisedly placed here and there in these basins to prevent the undersirable short-circuiting, and the cross sections of the passages under and around these baffles are computed to a considerable degree of nicety in order to avoid sudden increases in the velocity of flow, which would not only tend to break up the forming flocs of hydrate but sweep along with the flowing current matters already brought to rest on the bottom of the basin.

It is necessary to have drains of ample size from a sump in the basin and gates on these located in a dry chamber. There should also be arranged an overflow of adequate dimensions. It is very convenient to provide water under pressure, inside of the basin, where a hose may be attached for washing out the deposits. In this climate the basins must be decked over and covered with earth to prevent freezing, which necessitates manholes properly located for access and lighting.

Application of Coagulant Solutions.

No department of the purification process is more important than that wherein the coagulant solutions are applied to the raw water as it enters the coagulating and settling basins. As the character of the raw water changes, the dose of coagulant must be changed accordingly, and unless this is done intelligently, not only are poor filtration results to be anticipated, but a material waste of coagulant is unavoidable. This coagulant costs money. Probably all of one-third of the cost of operation of a filter plant is represented by the cost of the coagulant. Insufficient coagulant means poor results, and too much coagulant means unnecessary waste. If the filtration result is unsatisfactory through the use of insufficient coagulant, its cost has been largely thrown away, since no better than a poor result has come from its employment.

Where the devices for preparing coagulant solutions and the application of the same are clumsy, primitive, or require a great deal of manual attention the dose is liable to fluctuate sharply from time to time. This means alternate under and overdosing, which runs into considerable waste money. Our company has centered a fair share of the efforts of its designing staff on endeavors directed specifically to the perfection of appliances whereby the preparation and application of coagulant may be made substantially automatic and fool proof, and where a constant known

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quantity of solution can be fed and the quantity conveniently and quickly changed as desired.

There must be arranged in the plant a chemical storage room, chemical solution tanks, and chemical feeding devices. The storage room should be arranged for convenience in getting material into it and in moving the material. The solution tanks, if possible, should be arranged so that the top of the tanks comes at the level of the storage room floor. There should be two solution tanks. The capacity of one of these tanks should be figured to suffice for at least twelve hours' supply, under the maximum quantity of solution needed. The tanks are arranged with dissolving racks, in which the sulphate of alumina is placed, spray pipes for directing the water on to it, and agitators for keeping the solution agitated and of uniform strength. Various arrangements for these solution tanks are satisfactory, and from experience I would avoid only agitators operated from counter shaft, where belting and gearing is required. It is doubtful if it is good practice to use electric motors for driving the agitators. A water motor driven agitator for each tank is in every way a satisfactory arrangement. Where concrete tanks are used, some arrangement for protecting the concrete must be provided. A solution of sulphate of aluminum will attack concrete and in a short time eat away the surface of the concrete to a considerable extent. Present experience indicates that if the surface of the concrete, when dry, is treated with creosote oil and "Barrett Specification Pitch" it will remain unimpaired for years.

The piping from a solution tank will, of course, provide for drainage and also for taking the solution from the tank to the chemical feeding devices. The solution on passing from the tank should be filtered. This filter should have an area, so that the rate of filtration will be about 1.66 imperial gallons per square foot per minute. It may be arranged in the bottom of the solution tank or outside of the tank. Provision to wash back with clean water must be made. The filtering material is gravel, ranging in size from ⅛ in to ⅜ in. and the thickness of the material from 4 in. to 6 in. This little arrangement for filtering alum is most important, particularly on the small plants, and has been brought about entirely through experience.

The measuring devices for feeding the coagulant solution after filtering can be any arrangement whereby a constant known quantity of solution can be fed and by which this quantity can be conveniently and quickly changed. The solution from the feeding devices can be conducted to the point of application in lead pipe, or chemical hose, either by pumping so as to feed by gravity or through a pump suction box to feed to the suction of the low lift pumps.

Construction of the Filter Proper.

The rate of filtration adopted for mechanical filters is one hundred and four million imperial gallons per acre per day, or 1.66 gallons per square foot per minute. The general arrangement of modern filters is well known. The filter shell is usually made of reinforced concrete, rectangular in shape, and seven or eight feet deep. It is equipped with a strainer system at the bottom, about thirty-six inches of filter sand and gravel and wash water gutters at the top. Outside of the filter in the pipe gallery are located the pipes and valves for operating the filter.

The strainer system may be the combined or separate air system. On the design of the strainer system largely depends the uniform rate of filtration. This is so for two reasons—first, it must collect the water passing through the sand in uniform quantities over the whole area of the bed; second, it must distribute the wash water at a uniform rate over the whole bed. The distribution of the wash water is the most important detail to have correct in the filter. If this is defective or the water ways are too small, the washing of the bed is not uniform, and in a short time there will be alternate areas of clean and dirty sand.

The design of a strainer system for a bed having an area of 150 square feet, or less, should not be used for a bed of greater area—that is to say, a central manifold casting from which lateral pipes branch each way, to the sides of the bed, can be supplied with water from one end, while in beds of greater area the manifold pipe should receive its supply at the centre, or in very large beds, at two points. It is probable that a bed having an area of 420 square feet, which would equal a million imperial gallon unit, should be designed with a manifold at each side and the lateral pipes laid between them, thus effecting a pipe system without dead ends. The manifold and lateral pipes should be of cast iron. In filters of small area, however, genuine wrought iron pipe is used for laterals.

The strainer caps or strainer heads, sometimes called sand valves, are of numerous and widely varying designs. Many of them are covered by patents. They are made of brass or bronze, and so designed that the flow of water through them is broken up and equally distributed. Where the combined air and wash water system is used a brass trap tube is usually required.

Care in Placing Strainers.

The placing of the strainer system in the bottom of the filter should be done with great care, particularly if the combined system is used. It is very important that the strainer caps be practically level throughout the area of the bed, and a variation of over one-eighth of an inch is not permissible. Strainer caps should be spaced not more than 6 in. on centres. After the strainer system is in place, the whole should be embedded in lean concrete and the surface finished off with a layer of good cement mortar about ¼ in. thick. This surface should be brought level with the lowest water way to the strainer head.

Nine inches of properly graded gravel placed in the bottom of the bed is apparently sufficient. This gravel should be graded in size from ¾ in. to ⅛ in. On top of this 27 in. of carefully selected silica sand should be placed. The grading and the size of the sand is important from an economical point of view. If a sand not properly graded—that is, containing too large a percentage of fine particles—is used, the fine particles will eventually be washed out and it will be necessary to replace the material so lost. On the other hand, if the size of the sand is not larger than .60 millimeter and smaller than .37 millimeter, with a uniformity coefficient of 1.65, practically no waste will occur from fine particles being washed away.

Wash water gutters are constructed of concreete, sheet iron, steel, and of cast iron. The writer's experience has been with cast iron gutters, and they have been found satisfactory. The top edges of the gutters should be planed to a straight line, so as to permit the lip of all of the gutters in the bed to be set at one level. The distance above the surface of the sand, at which these gutters should be placed, depends upon what the rate of application of wash water is to be. If filter washing is to be aided by compressed air agitation, then a vertical rise of wash water of 13 inches per minute will suffice. If no air is used, but dependence laid upon what is known as the "high velocity wash," as used at Cincinnati, Ohio, and elsewhere, then a vertical

rise of wash water of 30 inches per minute is not uncommon. Naturally the whole sand bed is floated when wash water is forced upwards through it, and the higher the velocity of upward flow of this water the higher the sand layer will rise, consequently, to avoid loss of sand the wash water gutters must be placed sufficiently high so that whatever rate of application of water is employed the filter sand will not be washed out of the tank and so lost. The capacity of the gutter should be such as to carry off the flow when running within 1½ inches of full. It is important that the drain be so laid that air will not trap and cause a back-flow.

Wash Water and Air Application Devices.

The washing of the bed by first applying air to agitate the sand and then the water, can successfully be done with a quantity of water that will equal a vertical rise of 13 inches per minute. In filter beds where air is not used for agitating the sand, but where revolving rakes are used for agitating, a vertical rise of 12 inches per minute is sufficient.

Air for agitating the sand previous to washing should be supplied under a pressure of from 3½ to 4 pounds per square inch. The quantity of air should be not less than 3 cubic feet of free air per square foot per minute. A proper wash of a filter bed is often accomplished by agitating with air for two minutes and washing with water for four minutes.

Where air and water is adopted to wash filters, the wash water and air agitating equipment must be arranged to meet conditions. On small plants—that is, beds having an area of 65 square feet or less—the wash water may be obtained direct from the mains without dropping the pressure too much to cause annoyance. On plants larger than this and up to filters having a capacity of 1,000,000 gallons, a wash water pump is usually used. This pump should have sufficient capacity to furnish the required amount of wash water and be able to lift this water against a head equal to 16 feet above the lip of the gutter. The most convenient power to drive the pump is electricity, and where electricity is used, the starting device should be installed at a convenient point on the operating floor. Where units of a million gallons capacity or more are used, and particularly in plants of ten million gallons or greater capacity, it is probable that a wash water tower will work out to be more economical in operation and more efficient in service. The capacity of a wash water tank should be sufficient to wash one quarter of the filter units in succession. The storage capacity necessary for this quantity of water should be above a point 16 feet above the lip of the gutter. In connection with the storage tank there should be a regulating tank, or regulating device, that will drop the pressure of the water above the 16 foot level to 16 feet and maintain it at this level. Another factor that may work in and make a wash water tank desirable is the load that can be thrown on to the power available. A centrifugal wash water pump for a million gallon unit will usually require a 50 h.p. motor. This load of 50 h.p. may be thrown on at any time during the day for a matter of four or five minutes. When using a wash water tank a very small pump and motor is required. This pump and motor should have a capacity to restore in six hours the amount of water estimated for washing. This pump is started and stopped automatically by the pressure of water in the wash water tower or by a float. Filtered water should always be used for washing.

The air for agitating in all plants up to one million gallons capacity may be supplied direct from a rotary blower. Electric current is the most convenient for the motive power. The blower should deliver the air against a pressure of 3½ to 4 pounds. A blower of sufficient capacity to agitate a million gallon unit will require practically a 50 h.p. motor, and it may be, as stated above, that the available power will not permit of throwing as great a load as this on to the power. In connection with the wash water tower an air storage tank can be arranged. This tank is simply an inverted tank, similar to the arrangement for a gasometer, in the wash water tower. The air is supplied to this tank by rotary blowers of small capacity, working the same as the smaller wash water pumps. The storage capacity should be for sufficient air to wash one quarter of the filters in succession. The required air pressure is easily obtained by loading the tank with concrete.

A combined wash water and air tank, as described above, is used at the Montreal Water and Power Company's plant. In fact, this was the first combined air and wash water tank ever constructed, and the outfit as installed is satisfactory.

Controlling, Operating, and Indicating Devices.

It is necessary to control the effluent from the filters to a desired quantity of water, or desired rate of filtration. This is done by placing on the effluent line from the filter a controller. There are a number of different makes of controllers that operate satisfactorily. Most of them are of the venturi type, and the operation of controlling is actuated by the velocity head through the throat of the meter. The writer is more familiar with the Simplex type of controller than any other, and finds that this controller can be set to deliver the desired quantity of water, and that it will maintain this quantity very closely. It apparently is unnecessary, after a controller is once set, to readjust it at all. Like any other machine having moving parts, the packing around the spindle of the controller must be kept in condition and oiled, so as to produce the minimum amount of friction.

The operating valves for the filters may be either hand operated or hydraulically operated. On units of a capacity of one million gallons or more hydraulically-operated valves must be used in order to get efficient operation. It is probable on beds of this size that it will be necessary to use valves as large as 12 in. and 14 in., and you can understand that it requires considerable time and labor to operate these valves by hand. On the smaller plants hand-operated valves are entirely satisfactory and all that are necessary. Where hydraulic valves are used operating tables are necessary. These tables are preferably constructed of marble, and on the top of the table are arranged the levers for operating the several valves. The levers operate a pilot valve, which directs the water under pressure to the bottom or the top of the hydraulic cylinder on the valve. An indicator is attached to a spindle on the top of the hydraulic valve by wire and chain, and through an arrangement of gears indicates the movement of the valve, on the table. The operating table is usually placed directly in front of the filter. It is not necessary that it be placed in this exact position.

The only other accessory necessary in connection with the filter is the loss-of-head gauge. This gauge serves the purpose of indicating the loss of head on the filter—that is, as the filter begins to collect the matter being removed from the water, it requires that more pressure be released by the controller to drive the water through the bed, or through the collected matter on the surface of the bed. This pressure is termed loss of head. The gauge is usually arranged with two float

tubes—one connected directly to the filter, the water level in this tube coinciding with the level of the water in the filter; the other tube is connected to the effluent controller, and the water level in this tube varies according to the pressure in the effluent main. The difference in level between the water in the two tubes is transferred from floats by cords to the mechanism of the gauge, and is indicated by a pointer worked over a graduated dial. It is necessary to know what the loss of head on a filter is, for in this way the proper time for washing the filter is ascertained. There is arranged on the gauge an electric alarm, which will advise the operator when the bed is run out. These gauges may also be of the recording type, but the author believes an indicating loss-of-head gauge is to be preferred over a recording loss-of-head gauge. An indicating loss-of-head gauge is more simple in construction and requires less attention. By manually instead of automatically keeping the records of the loss of head on the filters the operator is required to pass through the operating room and to each filter every hour. If the operator does this, it is assurance of more efficient operation. On the other hand, with a recording loss-of-head gauge it is not necessary for the operator to go to the filters every hour, and for this reason the tendency is to neglect frequent inspection of the filters in operation. It has occurred, after washing a filter and placing it in operation again, that through a blunder the influent gate lever has been moved. This means that no water is coming to the filter and that the filter will run dry. With the recording loss-of-head gauge, not requiring the operator's presence in the operating room, this filter could stand dry for several hours. A visitor to a plant might move the levers on the operating tables and throw the filters out of operation, and for these reasons, as above stated, a device requiring the operator to take records every hour is preferable.

Clear Water Basin.

The clear water basin must necessarily be located, as to elevation, below the filters, and it is good designing to keep the high-water mark in the clear water basin below the level of the pipe gallery floor. The outside lines of the basin should, if possible, be worked in to make the whole plant symmetrical or to coincide with the lines of the outside of the filters and operating room. The capacity of the basin should be designed to meet local conditions. In a direct pumping system it should be sufficiently large to take care of a normal fire draft, after being drawn down to take care of the hourly daily variation. It is not necessary to provide against the contingencies of the filter plant being out of commission. With duplicate low lift pumping machinery or reasonable assurance of getting raw water to the plant the possibility of anything happening within the plant to put it out of commission is very remote. Extensions to the clear water basin outside of the limits of the plant are often made, where increased capacity is desired. It is necessary in a clear water basin to be sure that your design will permit of circulation through the basin. The down-draft tubes from the several filters will greatly assist in the circulation, but in large basins it will probably be necessary to install circulating baffles.

Some engineers and some state boards of health in the United States require that the clear water basin be a separate structure and well removed from the coagulating basin, influent flume, pipes conducting raw water, or the drain for wash water. This means that they would not permit of a clear water basin being constructed adjacent to the coagulating basin, with only a wall between. In designing it is often convenient to place the clear water basin so that the coagulating basin wall forms one wall of the clear water basin. Care must be taken, however, that this wall be watertight, and the design often calls for an extra thickness of concrete at this point. Experience indicates that this is good practice. It is not necessary to provide a drain from the clear water basin, nor is it necessary that there be an overflow. Automatic equipment can be placed on the filters that will shut them off when the basin is full. It is believed, however, that a high and low water alarm and a suitable indicating depth gauge is all that is necessary.

General.

The arrangement usually adapted in the layout of a filter plant has been to construct the filters on the opposite sides of a pipe gallery. The plant at Little Falls, N.J., the first large mechanical filter plant built, was so designed, and this plant seems to have been the grandfather of all other plants of modern type construction. Arranging filters on two sides of a pipe gallery appears to be economy in piping. On the other hand, it means a complication of piping, and it is very difficult to arrange the same so that the pipe gallery is accessible. Generally the influent main or influent flume is arranged in the centre of the gallery and at the top. Under this, and usually in the centre, is arranged the air main. Under this again, the wash water main, and on the floor of the pipe gallery the sewer. It is necessary that branches from all of these mains be carried to the sides or across the gallery to enter the filters, and it can be easily understood where the interruption to free access to the gallery occurs. Another thing, the pipe gallery is usually dark, without windows or proper ventilation. It is quite certain that in any pipe gallery, as above described, the valves operating the filters do not get proper attention, and that at least four out of five valves will be leaking at the stuffing boxes. It is only another case where "out of sight is out of mind," and, therefore, proper attention is not given to the piping equipment. The author prefers a design where all the filters are arranged at one side of the pipe gallery. This will often admit of the opposite side being an outside wall, where windows and proper ventilation can be arranged. It means that a clear space can be provided in front of the piping, and that all valves and other equipment can be conveniently reached. It also provides a place that is not out of sight, but the reverse, and the tendency is to keep the stuffing boxes on the valves tight in order to keep the floor free from water. It is possible to arrange a plant up to twenty million gallons capacity in this way.

Housing the Filters.

In the housing of the filters in this climate I would not again deck over a part of the filters. I believe that it is better practice to arrange the house to cover the entire area of the beds. Where filters are decked over and are covered with two and one-half feet of earth, in severe weather, colder than 15 degrees below zero, they will freeze at the back. Again, where the filters are arranged on one side of a pipe gallery the design will probably work out so that the water from the coagulating basin will enter at the back of the filters. In this case it is necessary that the hydraulic influent valve be placed at the back of the filter, and this valve must be protected against freezing.

The raw water supplied to the plant may in some cases reach it by gravity. It is, however, more often the case that pumps are required to lift the water into the plant. In filtration work these pumps are called low-lift pumps. It usually works out that the low-lift

pumping machinery is a part of the design of the filter plant, and space must be provided for this equipment. There is very little to be said about the arrangement of low-lift pumping machinery other than it should be arranged in duplicate and that the capacities of the pumps should be arranged for economical power consumption. Electrical driven centrifugal pumps are in every way satisfactory. Where interruption in electric service is liable to occur for any length of time, standby of some other convenient power should be arranged, or storage of clear water provided to carry over such interruption. The control of the water from the low-lift pump or from a gravity supply is necessary. The water level in the coagulating basin should be maintained at a constant level, and this is usually accomplished by placing at the end of the raw water main, in the inlet chamber to the coagulating basin, a butterfly valve. This valve has an extension rod, at the top of which, or at the high-water mark, is arranged a float for operating the valve. This arrangement is not altogether satisfactory. It is difficult to keep the water in the inlet chamber from freezing around the float and putting the controlling apparatus out of commission. A better way to control the flow to the basin is by arranging a float chamber inside of the plant. This chamber can be arranged at any point where the water from the coagulating basin can conveniently be conveyed to it. The chamber only need be large enough to accommodate the required number of floats and deep enough for them. In the raw water discharge main from the low-lift pumps and beyond any pump connection a hydraulic valve should be placed in the line. At the float chamber a pilot valve for operating the hydraulic valve can be arranged. The float operates through the pilot valve, the hydraulic valve cramping or opening the discharge from the pumps as required to maintain a constant level in the basin. This arrangement is satisfactory in every way.

Sterilization of the Effluent.

Almost every filter plant in operation to-day is treating the filtered effluent with a sterilizing agent, hypochlorite of lime or liquid chlorine being used. Hypochlorite of lime however, is being replaced by the use of liquid chlorine. There are liquid chlorine feeding devices on the market which are operating satisfactorily. The author's experience has been altogether with the Wallace and Tiernan chlorinators. Their solution feed machines are entirely satisfactory, and for small plants the machine operating with a pulsating motor is particularly satisfactory. The feeding of chlorine gas to the effluent passing from the filter plant, proportional to the amount of water flowing, is a problem requiring a good deal of study. There is no question but what the ideal way to chlorinate would be to chlorinate the effluent from each filter, or to collect the effluent of all the filters into a comparatively small area and chlorinate the water as it passes to the storage in the clear water basin. Any such arrangement as this, however, runs into so many complications that it does not seem feasible. Where a venturi meter can be arranged on the discharge line from the high service pumps, the velocity head through the motor can be used for operating the chlorinator and the chlorine solution fed to the suction of the pumps. Where such a meter cannot be arranged, a special venturi tube can be installed at the outlet of the clear water basin and the velocity head at the throat utilized, feeding the solution through a distributing pipe, directly in front of the outlet. It is, however, important and much to be preferred that an automatic proportional feed machine be used on plants of large capacity. On smaller plants satisfactory results can be obtained with manual control machines.

In any filter plant space should be provided for an office or storeroom, a room where small tools and supplies can be kept, and where a sink and bench can be arranged, to facilitate the making of alkalinity, turbidity, and color determinations. These small plants can arrange to have the bacterial work done at the laboratories of the Board of Health. In large plants office space, stool, and storage room, lavatories, and rooms for a complete chemical and bacterial laboratory are real necessities, and the arrangement of this part of the plant should be carefully laid out.

It requires very little labor to operate a filter plant. One man to a shift will handle a plant up to four million gallons without any difficulty. Two men to a shift will handle a plant from four million gallons to ten million gallons, and three men to a shift seems all that is necessary for a plant up to thirty million gallons. On a plant, however, of this size it is well to have an extra man on the day shift, a good mechanic or handy man. This man should spend most of his time in keeping the equipment in first-class condition. The operators and help should wear white suits while on duty. Careful records of the operation of a plant should be kept, and in large plants it is not only necessary but it is economical to have in charge of the plant a chemist and bacteriologist.

The speaker has yet to assist in building a plant which in general appearance and finish is up to what, in his opinion, an ideal plant should be. The inside finish of the operating room, for instance, is usually a concrete floor, brick walls, steel roof trusses, and painted roof boards. The outside of a filter plant is usually constructed of brick, with slate roofs. Extra money spent for tile floors, marble, tile, or terra cotta walls, parapet walls in front of the filters, attractive lighting scheme, ornamental receptacles for flowers or ferns, a ceiling and attractive radiators with concealed piping, would be money well spent. It is possible to design the lines of the buildings to have some desirable architectural features, and an architect should be employed for this purpose. The ground outside of the plant should be beautiful to the fullest possible extent. Every possible consideration should be given to building plants of better appearance and finish. The incentive would be to keep such plants clean and attractive.

Conclusion.

In conclusion, I wish to say that details in reference to automatic effluent controllers, master controllers, individual sample stands on operating tables, automatic proportional coagulant feeding devices, and dry coagulant feeds have been purposely avoided, all for a reason and with the hope that in the discussion of this paper the merits of these several devices may be brought out, and through the discussion some of us may be convinced that they are necessary adjuncts to a filter plant. Through the brief description that it is possible to give here of a modern mechanical gravity filter plant an effort has been made to convey to you that experience has brought about the perfection obtained at this time, and there is no question but what experience is going to teach us how to improve the several devices and methods now in use. The experience that is going to do this is where one man or a company of men have the opportunity of going through the experience of constructing and observing the operation of several plants each year.

Buildings of Heavy Timber Mill Construction (Continued)

By C. E. Paul, Construction Engineer

Cost of Mill Construction Buildings.

One of the important advantages of mill construction is the relatively lower cost when compared with other types of buildings. This feature has been recognized from the early days of this type of construction. With the advance in the cost of building materials as a whole, the relative difference between timber, steel, and concrete has changed slightly in favor of concrete, but the advantage as a whole is still on the side of mill construction. The old custom of using girders 45 feet in length and spanning three bays of a building has passed, but the same strength is now obtained by using shorter lengths of larger material of a high bending strength. Large timbers of great strength in proportion to weight are obtainable in all markets, and there is an ample supply of all sizes and grades in several different species.

Mill construction buildings vary in cost with the locality in which they are built. The cost per cubic foot will vary from 5c to 12c, with an average of about 8c. These costs are without the consideration of plumbing, heating, elevators, or other equipment. Such extras will increase the cost per cubic foot by 1c to 2c. The corresponding cost per square foot of floor area of building is from 50c to $1.50, with an average cost of about 90c. In order to obtain these reasonable costs, standard lengths and sizes of timber should be used, or else an extra amount will have to be charged for specials. The cost of such buildings may be kept to a minimum by careful decision in choosing length of spans and areas of floors. Each girder and floor plank should be used to its full capacity, as determined by the load rating of that floor. Areas of floors should be such that fire walls will not be needed between the different parts of a floor, thus keeping down the cost for protection of openings between rooms. A careful choosing of the sizes of bays will aid in the design of the sprinkler piping by making one or two lines of sprinklers do the work where more piping might be needed in case the spans were chosen without attention to this detail.

No General Law

An investigation conducted by J. Norman Jensen, architectural engineer, Chicago, showed that the range of costs in the three types of construction is so great that no generalization can be made. By comparing the costs of a large number of different types of construction the following conclusions were reached:

"With column spacing not exceeding 16 feet, mill construction buildings designed for 100 pounds per square foot live load cost 20 per cent. less than concrete buildings; for 150 pounds per square foot live load 15 per cent. less, and for 200 pounds per square foot live load, about 10 per cent. less. When the live load was 350 pounds per square foot or over, a concrete building was the cheaper."

This investigation showed also that when the column spacing in any building is greater than 16 feet the relative economy of mill construction disappeared. It has been found, however, that a column spacing of 16 feet is ample for the majority of buildings devoted to manufacturing or other mercantile businesses. For most light manufacturing buildings a live load of 100 pounds per square foot is sufficient, and for a large percent of the buildings used for storage purposes 200 pounds per square foot is all that will ever be placed on the floors.

An investigation in regard to the cost of insurance on mill construction, steel, and concrete buildings showed that in ordinary lines of business the rate of insurance on a sprinklered mill construction building and contents runs about 25 cents per $100, while the rate on a concrete building and contents unsprinklered runs about 45c. The rate on both types of construction sprinklered is about the same, but the cost of installing the sprinkler system in the concrete building may make the total cost higher in comparison with a mill construction building.

Unit Cost Varies with the Height

The unit cost of a building varies considerably with the height of structure. In connection with this point the following extracts from "Mill Buildings," by H. G. Tyrrell, is of interest:

"Mill construction buildings of one and two storeys cost more than buildings of three to five storeys, the last being about 15 per cent. less per square foot of gross floor area than when all floor space is on the ground. For light products it is, therefore, economical to make manufacturing buildings not less than three storeys in height, for not only is the building itself less expensive, but it also occupies smaller ground space. The only possible reason that might cause the owner of a building for light manufacturing purposes to select one floor in preference to three or more would be the relative convenience and economy of carrying on the work on a single floor. Records of certain factories show that the cost of labor is from 5 per cent. to 10 per cent. less when work is all done on a single floor rather than on several floors."

A further comparison of the cost of wood, reinforced concrete, and steel buildings is made by Mr. Tyrrell in his book "Engineering of Shops and Factories," as shown by the following extracts, in which A is the greatest cost and G the least:

"Building types, arranged in order of their relative first cost, are as follows:

"A. Complete steel frame, fireproofed, with curtain walls and plank floor.

"B. Interior steel frame, fireproofed, with solid brick walls and plank floor.

"C. Complete steel frame, fireproofed, with curtain walls and reinforced concrete floors.

"D. Interior steel frame, fireproofed, with solid brick walls and reinforced concrete floors.

"E. Entire reinforced concrete building.

"F. Part interior steel frame, not fireproofed, with solid brick walls and wood mill floors.

"G. Entire wood mill construction.

"In comparing the first cost of buildings in wood mill construction and in reinforced concrete it will be found that their relative cost varies with the location, size of building, and the floor loads to be sustained. In the Southern States, or other regions where timber is abundant and cheap, wood construction will often cost 25 per cent. to 30 per cent. less than reinforced concrete, while in districts where wood is scarce the two types may be nearly equal. The comparison depends also on the size of the building, for large ones have often been found to cost about the same in either material.

and small ones are sometimes more expensive by 30, 40, or 50 per cent. in reinforced concrete than in wood. The required floor capacity also affects the comparison. Light loads with long spans are cheaper in wood mill construction than in reinforced concrete, the cost of the two types being nearly equal in large buildings with 200 pounds imposed load per square foot, and column spacing of 18 to 20 feet. With loads of 300 to 500 pounds per square foot concrete becomes cheaper, and the saving increases rapidly with greater loads of 1,000 to 1,200 pounds per square foot."

The following extracts, taken from an address delivered before the Portland members of the West Coast Lumbermen's Association by C. J. Hogue, architect, Portland, Ore., are of interest, since they provide comparative data from that section of the country:

"As a result of twelve years' experience in New England I saw reinforced buildings (I am speaking from the standpoint of an engineer), concrete buildings constructed for within 5 to 15 per cent. of the cost of mill construction, and structural steel buildings at 10 to 25 per cent. additional cost. Of course in the cheaper types of wood construction there were more differences than with an engineering type. At that time the cost for mill-constructed buildings would have shown a greater difference than I found for reinforced concrete. As a matter of fact, we could not obtain low enough rates of insurance on sprinklered reinforced concrete buildings over sprinklered mill construction to pay the difference in the interest on cost of the two types of buildings.

"Since my return to Portland I have been ostensibly practising economy, so I can not give you the best of comparisons from my experience. But in the recent effort to relieve building conditions in the inner fire district, which resulted in eliminating one-third from the inner into the outer district, we took comparative figures on two buildings, one mill constructed and one of reinforced concrete. The two buildings were to cover an area of 100 by 100, plastered throughout, as if they were to be used for retail stores. The figure we received, without heating, lighting, plumbing, and elevator, for mill construction was $27,135, against $37,651 for the reinforced concrete building, an additional cost of 37 per cent. To those figures add $6,000 to both buildings for plumbing, etc., and the additional cost of the reinforced concrete building was 31.7 per cent. more than the cost of the mill-constructed building. This is because lumber is cheaper in the West than it is in the East, and cement, sand, and gravel are much more expensive.

"Now, the best comparison of safe types of fire-resisting construction can perhaps be shown by the comparative insurance rates—from the judgment of men whose business it is to study this question. We in Portland have secured comparative insurance rates—assuming occupancy of a furniture store and the rate on the wood construction building was 47 cents and on the fireproof building 35 cents, and with sprinklers the comparison was 28 cents on the mill and 21 cents on the fireproof. The rate was made on the building, not on the contents. The rate for the mill-constructed building, sprinklered, 28 cents, was less than on the unsprinklered fireproof building, 35 cents.

"I also had copies of fire rates from the Chicago Board of Fire Underwriters, assuming a machine shop occupancy. The rate on a building not sprinklered, mill construction, was $1.11, as against 24 cents for fireproof construction; and sprinklered, 15 cents for mill construction, as against 14 cents for fireproof material. The comparison between the sprinklered mill-construction building shows 15 cents, as against 24 cents for the non-sprinklered fireproof building; and where both are sprinklered only 1 cent difference, 15 cents for the mill construction and 14 cents for the fireproof. On the contents the rate on non-sprinklered mill construction was $1.36, as against 64 cents for the fireproof; the rates on the contents of sprinklered building were 30 cents for the mill, as against 26 cents for the fireproof building. The comparison there for the sprinklered mill constructed is 30 cents, as against 64 cents for the non-sprinklered fireproof building. This shows clearly that a sprinklered mill-construction building is a safer risk from a fire insurance standpoint than one of non-sprinklered fireproof construction.

"The sprinklered mill-constructed building is safer both as to building and contents than is a fireproof building, non-sprinklered. In the same way a mill-constructed building, with properly constructed stairways and elevator shafts, is safer as to contents than the non-sprinklered, unprotected stairway of a fireproof structure. Another thing is the temperature which runs from 1,000 to 1,200 degrees, as compared to 1,800 degrees in fireproof non-sprinklered buildings. The steel columns almost invariably buckle early in the game, and are of no further support to the building.

"I believe, from my experience in both kinds of construction, that the mill-constructed building, masonry walls, wire glass windows, equipped with a sprinkler system, would have almost as great effect in stopping a conflagration as if the interior was of so-called fireproof construction—that is, of incombustible materials.'

Reinforced Concrete Building Design

Recommended Specifications for Structures to be Erected in Cities Not Having a Building Ordinance

Continued from Issue of Dec. 13

Slabs, Beams and Girders

The straight-line method shall be used in designing reinforced concrete.

The span length for beams simply supported, and for all slabs, shall be taken as the distance from centre to centre of supports, but need not be taken to exceed the clear span plus the over-all depth of beam or slab. For continuous or restrained beams built monolithically into supports, the span length may be taken as the clear distance between faces of supports. Brackets shall not be considered as reducing the clear span in the sense here intended, and the clear span between T beams is the distance face to face of stems. Maximum negative moments are to be considered as existing at the end of the span as here defined.

The bending moments of girders, beams and slabs due to uniformly distributed loads shall be taken as not less than:

1/8 WL, at centre when simply supported.

1/9 WL, over central support; and 1/10 WL, near the middle of the span when continuous for two spans only.

1/10 WL, over first continuous support; and 1/10 WL, near middle of end spans when supported at one end and continuous at the other end for more than two spans.

1/12 WL, at centre and intermediate supports when continuous over more than two supports.

The simply supported ends of spans shall be reinforced for a negative moment of not less than 1/16 WL.

W = total distributed dead and live loads.

L = length of span.

Floor slabs having supports extending along the four sides shall be designed and reinforced as continuous over the supports. For uniformly distributed dead and live loads the per cent of load carried on the transverse span shall be found by subtracting 0.5 from the quotient obtained by dividing the length by the breadth. The remainder of the load shall be carried on the longitudinal span. If the length of the slab exceeds 1.5 times its width the entire load shall be carried on the transverse span. Using the values thus obtained, each set of reinforcement is to be calculated in the same manner as slabs having supports on two supports only, using correct depths to centre of steel. The amount of reinforcement thus determined per foot of width applies only to the middle half of the slab and one-half of this amount per foot of width may be used in each end quarter of the slab. The probable distribution of the loads from two-way reinforced slabs to supporting beams or girders shall be ascertained, and the moments in the beams or girders calculated accordingly.

The bending moments for slabs or beams with spans of unusual length or due to other than uniformly distributed loads shall be more exactly computed according to accepted theory.

Provision for Negative Bending Moments

In continuous slabs, beams or girders, full provision shall be made for the negative bending moments over the supports by placing sufficient negative reinforcement near the top of the members to resist the stress. This reinforcement shall pass beyond the point of contra-flexure in beams or girders and be anchored in the compression concrete of the member a sufficient distance to develop the full strength of the steel through bond stress. The critical section of continuous construction is over the support.

Where adequate bond is provided at junction between slab and beam, and the two are cast at the same time as a unit, the slab may be considered as an integral part of the beam, provided its effective width shall not exceed one-fourth of the span length of the beam, nor be greater than six times the thickness of the slab on either side of the stem.

In beams with **T** sections the width of the stem only shall be used in calculating longitudinal shear and diagonal tension. An effective bond shall be provided at the junction of the beam and slab when the principal slab reinforcement is parallel to the beam, by the use of transverse reinforcement extending over the beam and well into the slab.

In the design of **T** beams acting as continuous beams, sufficient compression area shall be provided on the under side at the support, either by the use of properly designed brackets or by embedding additional compression steel in the concrete extending to the point of inflection.

The minimum thickness of concrete floor slabs shall be 4 inches, and of roof slabs 3½ inches.

Cement or concrete floor finish shall not be considered in calculating the strength of floor members unless it be laid at the same time they are cast.

The design of composite floors consisting of rows of concrete tile or hard-burned terra cotta tile, gypsum blocks, sheet steel, or other approved fire resisting material, separated by ribs, or beams of reinforced stone concrete, shall conform to all the provisions of these specifications so far as they are applicable. Not less than two bars shall be used in each rib with a minimum space between bars of one inch. The width of ribs shall be two inches plus the widths of the bars plus the spaces between the bars but the minimum width of ribs shall be four inches.

The tile or blocks shall be regarded only as fillers, and shall not be considered in the design except as a dead load.

If designed as a **T** beam, the slab portion above the fillers shall have a thickness of at least one-fifth the depth from the top surface to the centre of the steel and not less than 1½ inches, and shall consist of the same mixture used for the ribs, and shall be cast at the same time. Under these conditions it may be considered in the design of the ribs.

Tile or block fillers shall be laid with Portland cement mortar joints, and shall be thoroughly wet before the concrete is poured.

The protection for steel bars in the bottom of ribs shall be the same as for other beams.

To resist expansion and shrinkage stresses, reinforcement bars not less than one-half inch diameter shall be placed in the concrete at right angles to the ribs and above the fillers, at intervals not exceeding 30 inches.

Steel reinforcement shall have a minimum protection of concrete on all sides as follows:

In columns and girders, 2 inches; in beams and walls, 1½ inches; and in floor slabs, 1 inch.

The steel in footings for walls and columns shall have a minimum protection of 4 inches of concrete.

All reinforcement shall be accurately located and mechanically secured against displacement during the placing of the concrete. Reinforcement bars for slabs shall not be spaced farther apart than two and one-half times the thickness of the slab. The spacing of parallel bars in beams shall be not less than two diameters from centre to centre, nor less than one inch. The clear spacing between two parallel layers of bars shall not be less than one inch. In restrained or cantilever construction reinforcement shall extend beyond the supports into adjacent construction for full and effective anchorage, except that when that is not practicable, anchorage shall be obtained by other means acceptable to the (Engineer or Architect).

Special reinforcement shall be provided to resist concentrated loads.

Slabs reinforced in one direction only shall have shrinkage rods not less than ¼-inch in diameter placed above, and crossing the reinforcement and spaced not over two feet apart.

All reinforcement shall be assembled well in advance of the placing of the concrete, and shall be inspected and approved by the (Engineer or Architect) before concrete is deposited.

Splices in Bars

Splices in reinforcing bars shall be designed to transfer the calculated stress at the joint either by bond and shear through the concrete or in vertical supports by bearing between the steel. Splices at points of maximum stress shall be avoided where possible. Lap splices of bars shall be of sufficient length to develop the required stress in the joint without

exceeding the bond stress permitted, and the lapped portions shall be separated by a space not less than their thickness or a minimum of one inch.

Members of web reinforcement in beams shall be designed for diagonal tensile stresses, using the calculated vertical shearing stress as a measure of these tensile stresses. The longitudinal spacing of vertical stirrups shall not exceed one-half the depth of beam and that of inclined members shall not exceed three-fourths of the depth of beam. It may be assumed that all of the external vertical shear in excess of the amount heretofore specified as allowable for concrete is provided for by the steel in vertical or inclined web members and bent up bars.

Web members, such as stirrups, when not rigidly attached to the longitudinal steel at both top and bottom, shall be carried around and bent over the longitudinal members or otherwise sufficiently anchored in the compression concrete to develop the tensile stresses existing in them. Web members shall be rigidly attached to the longitudinal steel on the tension side. Stirrups at the ends of continuous girders shall be inverted with the free ends anhored in the compression concrete at the bottom of the beam. The length of stirrups or diagonals embedded in compression concrete shall be sufficient to develop their entire tensile stresses by adhesion.

Columns

The length of columns shall be taken as the maximum unsupported length.

The unsupported length of columns shall not exceed 15 times the effective diameter or least effective thickness when longitudinally reinforced nor 10 times the effective diameter for hooped columns, and in no case shall the effective diameter or least effective thickness be less than 9 inches, measured within the ties or hooping from out to out of the longitudinal reinforcement. The length shall include any corbel or knee brace attached to the column. The effective diameter of columns supporting girderless floors shall be not less than one-twelfth the least panel dimension of panels supported by any column.

Bending stresses in columns due to eccentric loads shall be provided for by increasing the section of concrete or steel so that the total unit stress shall not exceed the allowable working stress in flexure.

Suitable steel base plates or castings shall be provided at the bottom of columns to distribute the loads over the footings, and the vertical reinforcement bars shall bear squarely on these plates or the reinforcing bars shall be carried down into an enlarged footing to distribute the load through bond stress.

In columns where necessary to splice vertical bars having areas in excess of 1¼ square inches, it shall be done by cutting the bars squarely at the ends and enclosing them in a close-fitting pipe sleeve, or uniting them by a threaded splice or other mechanical connection that will transfer the load from one to the other without stressing the adjoining concrete excessively. The middle point of such splices shall be within 1 foot above the floor level. Splices in column hooping where necessary shall be sufficient to develop the full strength of the hooping.

All interior columns shall be round. When interior columns other than round are used for architectural effect, the corners shall be made of plaster on metal lath built around the columns after they are fully set.

Longitudinally reinforced columns shall have not less than four vertical bars or rods secured against lateral displacement by steel ties placed not farther apart than 16 diameters of the vertical bars or rods, nor more than 12 inches. The area of the vertical reinforcement shall be not less than 1 per cent. nor more than 4 per cent., calculated upon the effective area of the column, which is the area within the reinforcement. No vertical bar shall have a diameter or least dimension less than ⅝ inch and steel ties shall be not less than ¼ inch in diameter or least dimension.

Hooped Columns

Hooped columns shall be reinforced with vertical steel with an area of not less than 1 per cent. and not more than 4 per cent., calculated upon the effective area of the column. The vertical bars or rods shall be spaced no farther apart than one-eighth the circumference nor more than 8 inches, and be secured to the hooping. The reinforcement, in the form of hoops or spirals, shall be not less than 1 per cent. (that is, a volume of steel equal to the required per cent. of the volume of concrete within the hoops or spirals for a unit length of column), with a clear spacing not greater than one-sixth the effective diameter, and preferably not greater than one-tenth the effective diameter, nor more than 2½ inches. For hooped columns reinforced as herein specified, the unit concrete stresses may be 700 pounds per square inch for 1:2:4 concrete and 870 pounds per square inch for 1:1½:3 concrete.

The load which may be carried by any column shall be determined by the following formula:

$$P = f_c (A_c + nA_s)$$

in which:

P = total load in pounds.
f_c = allowable compressive fiber stress in pounds per sq. in. on the concrete.
A_c = effective area of concrete in square inches.
n = ratio of deformation.
A_s = area of vertical steel in square inches.

Axial compression in structural steel columns thoroughly encased in concrete having a minimum thickness of 4 inches and reinforced with not less than 1 per cent. of hooping steel (that is, a volume of steel equal to 1 per cent. of the volume of concrete within the hoops), equally divided between vertical reinforcement and spirals or hoops spaced not more than 12 inches apart, may be taken at 16,000 pounds per square inch on the net section of the structural steel, no allowance being made for the concrete casing. The spirals or hoops shall be placed not nearer than 1 inch from surface of the concrete. The ratio of length to least radius of gyration of the structural steel section shall not exceed 120.

Walls

Exterior and interior bearing and non-bearing walls of reinforced concrete shall be securely anchored to all intersecting walls, columns and floors, and the allowable compressive stress shall not exceed 250 pounds per square inch. The thickness shall be not less than two-thirds that specified for brick walls, and in no case less than 8 inches. All such walls shall be reinforced with steel running both horizontally and vertically. The amount of reinforcement shall not be less than one-fifth of 1 per cent. of the cross section of the wall, and shall be equally disposed near each face of wall; except that in walls or partitions 8 inches or less in thickness, the reinforcement may be placed as a single layer in the middle. Reinforcement shall be spaced not more than 18 inches apart. Additional reinforce-

(Continued on page 1220)

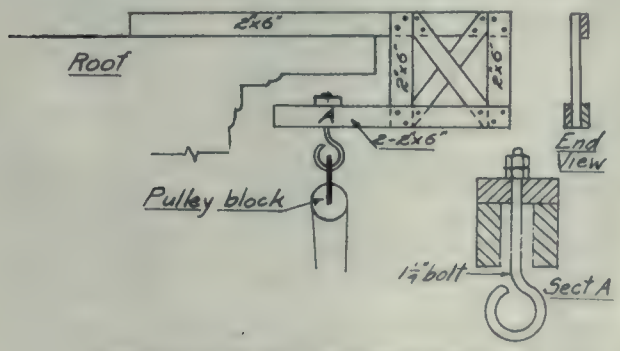
Practical Hints for the Contractor

that may save him time and money. If you know any labor-saving scheme, send it in—preferably with illustrations. We will pay for all accepted articles.

A Swing Scaffold

The usual pole or trestle scaffold commonly used in the erection of buildings is objectionable in that the framework is so intricate as to often interfere with the building operations. A scaffold of this type is usually a very clumsy and spreading structure. For stuccoing or plastering, more especially when a cement gun is employed, a clear unencumbered stretch of wall surface is desirable, and for this reason, a pole scaffold is not the best that may be adopted. To overcome these inherent disadvantages, swing scaffolds are sometimes employed. Such scaffolds are also readily arranged to allow rapid adjustment of height. There are many varieties of this type of platform, the usual arrangement being a few planks suspended by pulley blocks from an iron hook that catches on the roof cornice or eave.

The illustrations reproduced herewith show details of a swing scaffold of this type that has been devised for cement gun work on the Whitby Hospital for the Insane. The mode of support from the roof is rather different from the usual method. A wooden frame of the shape shown, which rests freely on the roof, is used for this purpose. A hook inserted as shown carries a pulley block and the point of suspension is kept well back of the roof edge so as to avoid any cantilever action and eliminate the need of counterweights to hold the frames. Of course, such a frame is applicable only to roofs with projecting cornices. These

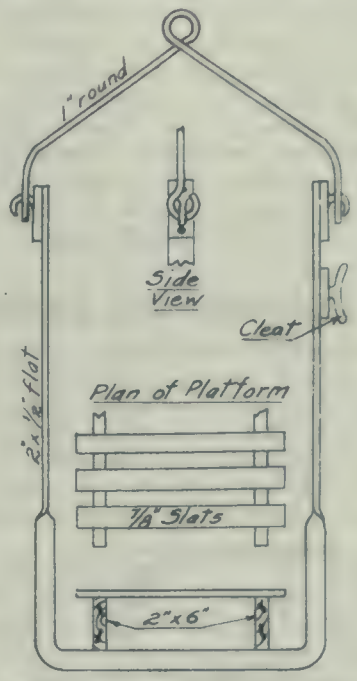


Method of supporting swing scaffold from roof.

wooden supports are handier than iron hooks, are more easily handled and can be instantly shifted from point to point on the roof. This method of suspension ensures safety to the workman on the scaffold.

In this particular case the platform was built of two 2 in. by 6 in. planks on edge, covered with ⅞-in. slats forming a platform 24 inches wide. To carry these, special brackets or loops forged of iron were used, shown in detail in the illustration, and placed about 14 ft. centres. Iron plates on the platforms provided a coupling for joining adjacent platforms to form a continuous series. This platform may be raised or lowered by the workmen on it, a cleat on the bracket holding the rope fast.

For cement gun work, this platform is admirable, since it provides a clear space for the gun manipulator



Platform and bracket for swing scaffold.

to work on. The screeder can also work at a closer range, and can finish the plaster as soon as it is applied.

An Improvised Hoist

Builders of houses or small buildings could make great use of a portable power-driven hoist. Until recently there has been nothing to fill this need and yet there are dozens of processes in the erection of a small building that would make such an equipment economical and profitable in time or labor. The nature of this class of work makes the use of the standard heavy hoisting engines almost impossible. What is desired is a light, compact, self-contained hoisting unit that may readily be moved from place to place.

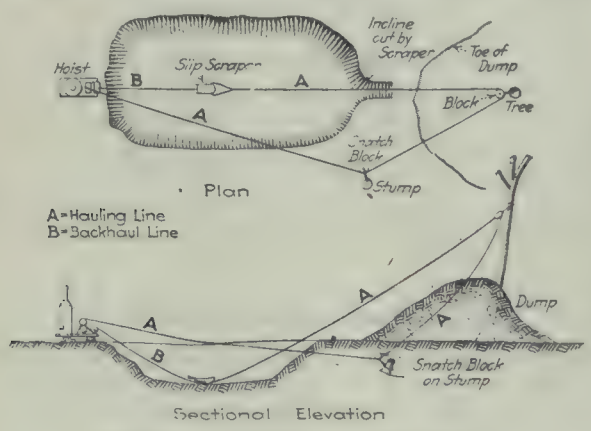
In connection with the work at the new Whitby Hospital for the Insane, constructed by the Ontario Provincial Government, a home-made hoist of this nature was built that is declared to be one of the most profitable pieces of contracting machinery on the job. The hoist was assembled from odd pieces that were not being employed to better advantage and illustrates what other builders may do with a little ingenuity towards providing themselves with a most useful piece of equipment.

The frame of an old portable rock-crusher was used to carry the drum and engine. On one end was mounted a single cylinder gasoline engine that was originally meant for pumping purposes, but which was

not of sufficient power to pump against the head desired. One drum of a two-drum hoisting engine was fastened at the opposite end of the crusher frame and was belt driven from the engine. To allow the belt to drive on the toothed gear which was attached to the drum a strap of wood blocks cut to fit the teeth was wired to the periphery of the gear, in this way forming a flat pulley surface. A friction brake was provided and also a clutch to disconnect the engine from the drum. To complete the equipment a small steel builder's derrick with a boom 5 to 6 feet long was used on the upper floor or roof, over which the wire hoisting rope passed, the end being weighted to ensure its being down ordinarily. By means of this improvised apparatus the brick and tiles used for the upper storeys were raised to the setters. The whole wheelbarrow was slung to the hook and elevated to the required position, where the derrick could swing it over the floor. The descent of a load was controlled entirely by the brake, the engine clutch being out so that the drum runs free. The engine is thus used for hoisting the load only, the brake forming a very convenient method of controlling the descent.

Dragline Excavating with Endless Cable

In excavating the foundation pit for a set of floodgates in the Brevoort levee, in Indiana, the contractor rigged up a dragline outfit, as shown in the accompanying sketch. A hoisting engine was placed at one side of the pit, with a backhaul cable hitched to an ordinary slip scraper. The hauling line was run clear of the pit through a snatchblock at one side and then up to



Excavating by scrapers on an endless rope.

a block attached to a tree in line with the hoisting engine, from which the cable led back to a bail on the scraper.

Men in the pit held the scraper by its handles to give it a load and start it up the incline, which it cut for itself. One man was stationed on the dump. Some trouble was experienced in dumping, but on the whole the rig worked very well; as the excavation was small, nothing more elaborate was needed. The material was a soft and wet but very sticky mud, in which the men worked with difficulty, both in the pit and on the dump. —Engineering News.

[The same plan was recently adopted at the Whitby Hospital for the Insane.—Ed.]

The Turbine Equipment Company have been awarded a contract for centrifugal sewage pumps for the town of New Toronto. Two of these will be driven by vertical motors and the other will be direct connected to a high speed gasoline engine.

Temporary Station for C. N. R. at Mount Royal Tunnel, Montreal

Tenders have been called by the Mount Royal Tunnel and Terminal Company, Limited, for the construction of the temporary station of the C. N. R., in connection with the suburban traffic of the Mount Royal tunnel service and the main line traffic of the C. N. R. It was originally intended to have built a very extensive terminal in Montreal, but owing to the war it was decided to put up a temporary station, and this will probably be utilized as part of the larger scheme at a later date. The Mount Royal tunnel is nearing completion, and with this fact in view, it is necessary to construct a station to accommodate the suburban business. The plans are by Warren & Wetmore, New York, who have also designed the larger terminal.

The site, on St. Dominique and Lagauchetiere Streets, is 106 x 135. The structure is to be entirely of reinforced concrete, without much ornamentation, and for a temporary building is of unusual strength. It will consist of a basement and two storeys. The entrance is on Lagauchetiere Street, and will comprise six doorways covered by a marquise. Above this there are to be five panels, with the words "Canadian Northern" in the centres.

The basement is to be 15 feet below the street level; here will be located the concourse and the five tracks. Access to the concourse will be given by a stairway from the ground floor. Between the concourse and the tracks a large space is to be reserved for a baggage way run, this communicating with the baggage room situated at one side. On the west section of the station a 30-foot drive for baggage is to be constructed; the goods will be unloaded at the first floor level, and lowered by a freight elevator into the baggage room.

On the first or ground floor will be the entrances, the centre of the floor being occupied by the vestibule, the ticket office, and the main waiting room. At one side will be the parcel room, the incoming baggage room, and the freight elevator, and at the other men's smoking room, toilets, and women's waiting room.

The next storey, which covers only the front part of the station, is to be for the transportation and engineers' offices, and will be reached by a stairway from the ground floor.

The walls and ceilings of the building are to be of plaster, and the floors of concrete, with the exception of the lavatories, where the floors are to be of tile. The partitions in the lavatories will be of marble. The ticket office will have bronze grills. The roof will be of asbestos felt.

It is intended to construct a boiler house for heating, but its location has not been settled.

Reinforced Concrete Building Design

(Continued from page 1218)

ment shall be placed around wall openings, and all vertical and horizontal reinforcement shall be wired or have other mechanical bond at intervals not exceeding 18 inches in either direction.

General

The 1916 Report of the Joint Committee on Concrete and Reinforced Concrete shall be followed in the design of girderless slabs, and it shall be the final authority in interpreting these specifications and applying same to unusual cases of spans and loading.

Personals

Mr. Geo. Young has resigned his position as Provincial Sanitary Inspector at North Bay, Ont., on account of ill health. He is succeeded by Mr. Alex. R. White.

Mr. W. B. Young, chief draughtsman and designer in the city engineer's department at Vancouver, has been granted a Commission in the Canadian Engineers and has been given leave of absence by the civic board of works to go overseas.

Mr. Robert Parker, a well-known contractor, of Windsor, Ont., has been appointed building inspector for that city. He will hereafter have charge of the issuing of building permits. Mr. Parker was a member of the board that framed the new building by-law which has finally been adopted.

Mr. Fred W. Evans has been appointed manager of the Toronto House of the Canadian Fairbanks-Morse Company, Limited, at 26-28 Front Street West. Mr. Evans has been acting-manager at Toronto for the past year and his appointment is a recognition of the excellent work he has done during that time. He has been with this company for a great many years and has had excellent experience, particularly in the machine tool end of the business.

Flight-Lieut. John H. Firstbrook, of the Royal Flying Corps, is now at Berne, Switzerland, having been transferred from a German prison camp, where he has been since last July. After qualifying for a commission in the Corps of Guides, he went to England to obtain a commission in the Royal Flying Corps. He was given his commission early this year and had been on active service for some months with the 22nd Squadron when he was wounded on July 1. Lieut. Firstbrook was a student at the School of Practical Science, Toronto.

Obituary

Mr. Daniel Wade, who for many years carried on business in London, Ont., as a brick manufacturer and retail lumber merchant, died recently after a long illness.

Mainly Constructional

East and West—From Coast to Coast

The total value of the building permits issued this year in Sault Ste. Marie, Ont., is $101,455, as compared with $69,430 last year.

The General Machinery & Equipment Company, Limited, has been incorporated with a capital of $10,000, head office at Vancouver.

During the year, building permits to the value of $170,420 have been issued in Brockville, Ont., as compared with $46,010 in 1915.

Rumors are again current that negotiations are in prospect regarding a merger of the Nova Scotia Steel & Coal Company and the Dominion Steel Corporation.

It is expected that there will be great activity in the building trade in Hamilton, Ont., in the spring; at the present time there is claimed to be a shortage of houses.

Building permits issued in the city of Quebec during the month of November number 46 and are valued at $783,875. This compares with 74 permits issued in the same month last year, value $349,275.

It is stated that work on the new elevator at St. John, N.B., will be commenced in the spring by the Fegles-Bellows Company, who have the contract, and that the work will take about eight months to complete.

At a meeting of the town council of St. Mary's, Ont., recently, Mr. A. B. Manson, C.E., the city engineer of Stratford, gave estimates of the new sewer system and disposal plant for St. Mary's, the amount being $17,721.

The brick plant at the Drummond Colliery, Westville, N.S., is said now to be more prosperous than ever before in its history. The output of fire brick exceeds 100,000 per month and a ready market at a good price is found at the steel plants at Sydney and Sydney Mines.

The Brantford, Ont., city council have adopted the recommendation of City Engineer Jones and the Medical Officer of Health, that mechanical filtration be used for Brantford's water supply, and that the supply be secured from the Grand River north of the present inlet.

General Manager E. L. Cousins, of the Toronto Harbor Board, has reported to City Council that up to the end of November a total of $1,014,411 had been spent on the harbor improvements. In November the Board spent $119,828. The total appropriation to date has been $2,693,896.

The appropriation which the Dominion Parliament will be asked to make for the Public Works Department at the opening of the session next month will be about $14,000,000, according to a statement recently made by Hon. Robert Rogers, Minister of Public Works. This compares with the grant of $48,000,000 made in the spring of 1914

A sewerage system for the populated district in the neighborhood of Long Branch, Ont., is under consideration, and Mr. E. M. Proctor has been making investigations as to the most satisfactory methods to be adopted. Two systems have been suggested—one of carrying the sewage to New Toronto and thence to Mimico, and another of building a small disposal works in the neighborhood of Etobicoke Creek.

A report is being made and plans submitted to the township of Scarboro by Messrs. James, Loudon & Hertzberg, Limited, for a system of water distribution for the district between the eastern limits of Toronto and the east boundary of Birch Cliff. Should the city of Toronto approve, this system will be supplied from the civic waterworks and provision will be made for a domestic supply as well as for fire protection in the populated area in the southwest corner of the township of Scarboro.

As a result of the harbor policy adopted at Vancouver, the Vulcan Iron Works will locate at False Creek on the ground reclaimed by the Harbor Commission. Plans have already been prepared and erection is to start on the new building immediately. The investment to be made will amount to $200,000, and one hundred men will be employed. The plant is to be most up-to-date and the handling facilities first-class, the intention being to install electric cranes. The firm have sufficient orders on hand to keep them busy for twelve months. They will make a specialty of Scotch marine boilers, which in the past have very largely been imported from Scotland.

Over $17,300 was spent on public works in the city of Fredericton, N.B., during the year 1916, according to a statement made by City Engineer Geo. McKnight. This amount includes the expenditure on permanent work and repair work, the entire renovation of the city plant and the enlargement of the Roads and Street Department. During the past season, over $1,800 was expended on roads and streets. An outlay of more than $1,400 was made in repairing the plant, $849.75 for material and $560 for labor in connection with the repair work. The building of a new barn, blacksmith shop, boiler house, engine base and purchase of horses cost $1,342.78. The cost of the permanent work done amounted to $3,004.74, considerable new concrete crub and gutter and concrete sewer wells being built, the latter numbering 38. On new streets $626.04 was spent, and the expenditure on roads leading into the city exceeded $1,100, twenty-three bridges and culverts being repaired.

Contracts Department

News of Special Interest to Contractors, Engineers, Manufacturers and Dealers in Building Supplies

Waterworks, Sewerage and Roadways

Amherst, N.S.
The Town Council contemplate the purchase of a motor-driven centrifugal pump in connection with the waterworks system. Clerk, W. F. Donkin.

Chatham, Ont.
The City Council contemplate laying pavement on Lacroix Street. Clerk, W. R. Merritt.

Halifax, N.S.
The City Council are considering the construction of several sewers and watermains, including work in connection with the Northwest Arm sewer project. Acting City Engineer, H. Johnston.

Hamilton-Beamsville, Ont.
The Provincial Government will be petitioned by the municipalities concerned to make surveys and estimate the cost of a highway between Hamilton and Beamsville.

Islington, Ont.
The Township of Etobicoke propose to construct a waterworks system, at an approximate cost of $75,000, and will submit a by-law. The scheme includes the erection of a pumping station at Darling Creek, the construction of a reservoir, trunk feeder, and seven miles of mains. Engineer, E. A. James, 57 Adelaide Street East, Toronto.

Sault Ste. Marie, Ont.
The City Council are considering the construction of a storm sewer, at an approximate cost of $34,500, and will submit a by-law in January. Clerk, R. G. Campbell.

Scarboro Township, Ont.
James, Loudon & Hertzberg, Excelsior Life Building, Toronto, have prepared a report on the construction of a water system in the township east of the city limits, and work will start in the spring if the city will supply water. Township Clerk, W. D. Annis, Scarboro.

Smith's Falls, Ont.
The Town Clerk, J. A. Lewis, will receive tenders until noon, January 15th, for the construction of about 2,700 feet of watermain and sewer. Plans and specifications at office of the engineer, S. B. Code. Approximate cost, $16,000.

Railroads, Bridges and Wharves

Fort William, Ont.
The construction of a bridge over the Pigeon River is being considered by the Cities of Fort William and Port Arthur, et al. Approximate cost, $3,000.

Galt, Ont.
The Canadian Pacific Railway contemplate the construction of a subway on Macadamized Road, and will take the matter up next year. Divisional engineer, A. L. Hertzberg, Toronto.

Montrose, Ont.
The Dominion Government Department of Public Works propose to construct a dam here instead of at Port Robinson. Secretary, R. C. Desrochers, Ottawa.

Winnipeg, Man.
Brown & Rutherford, Sutherland and Buchanan Streets, are building a wharf under the supervision of Roberts & Frith, 269 Linwood Steet, St. James, Man. Timber construction; length, 315 feet.

Public Buildings, Churches and Schools

Radisson, Sask.
The Town Council are considering the erection of a hospital. Clerk, A. H. Clark.

Sault Ste. Marie, Ont.
The Public School Board have appointed T. R. Wilks, Farwell Building, Queen Street, as architect for the proposed Moffly High School. The building will contain six rooms.

South Vancouver, B.C.
The erection of a children's creche is now under consideration. The Victoria Order of Nurses, 1800 Cook Street, are interested in the project.

St. Eleuthere, Que.
Tenders on the erection of five schools will be received until January 8th by L. S. Tardif, St. Leuthere, secretary to the School Board of Pohenegamouk Township. Mill and brick construction. Approximate cost, $4,000.

St. Victor de Tring, Que.
Tenders on the proposed college will be called by Father Caron, who has the plans and specifications. Architect, J. S. Bergeron, 103 St. John Street, Quebec. Stone, brick, and steel construction.

Vancouver, B.C.
The General Hospital Board are having preliminary sketches prepared for a hospital building, estimated to cost $35,000. Frame construction. Secretary, George Haddon.

CONTRACTS AWARDED.

Lennoxville, Que.
In connection with the erection of a school for Bishops College School Corporation the contract for steel work has been let to the Dominion Bridge Company, Lachine; roofing, McFarlane, Douglas Company, Ltd., 34a Dorchester Street West, Montreal; electrical work, Collyer & Brock, 131 St. Alexander Street; plumbing and heating, T. O'Connell, 183 Ottawa Street.

Montreal, Que.
The St. Henry School Commission, Place St. Henri, have let the following contracts for the erection of a school on Workman Street: Foundations and stone work, O. Filion & Frere, 2419 St. Denis Street; carpentry, Pauze & Fils, 326 Greene Avenue; electrical work, Vallee & Hamlin, 1867 St. James Street; plumbing and heatinng, Ducharme, Blais & Co., 1955 St. James Street; plastering, Z. Bouchard, 12 Bourget Street; brick work, C. Morin, 992 Talleyrand Avenue; tiling, Lepage Marble Works, 734 St. Lawrence Street. Approximate cost, $70,000.

New Toronto, Ont.
The contract for masonry, steel work, concrete and cut stone required in the erection of a school has been awarded to Albert Webb, 13 Shirley Avenue, Toronto, and the plumbing and heating to J. H. Doughty, Lake Shore Road. Approximate cost, $20,000. Architects, Smith & Wright, Baby Point Crescent, Toronto.

Normandin, Que.
The general contract for the erection of a church for the Parish of St. Cyrille de Normandin has been let to Edmond Tremblay, St. Anne de Chicoutimi, Que. Approximate cost, $125,000. Architect, J. P. Ouellet, 28 Ste. Famille Street, Quebec.

Ottawa, Ont.
The contract for the erection of an ice house in connection with the Perley Memorial Home, Aylmer Avenue, has been let to W. G. Adamson, 126 Sparks Street, who will do all work. Frame construction.

St. Octave, Que.
The general contract for interior work at the Parish Church has been let to J. H. Morin & Fils, Trois-Pistoles, Que. Approximate cost, $26,125.

Business Buildings and Industrial Plants

Chatham, Ont.
The Imperial Oil Company, Sarnia, Ont., propose to construct a refinery on Payne Street, and have purchased a site.

Collingwood, Ont.
James Vancise is asking the Council for concessions preparatory to the erection of an evaporator. Cement and brick construction.

Fort William, Ont.
The Western Terminal Elevator Company, West Fort William, propose to build an elevator, and have had plans prepared.

Fredericton, N.B.
Tenders on the erection of a garage for R. L. Phillips, 189 Smythe Street, will be received from February 10th to 20th by the owner. Brick or concrete construction.

Hamilton, Ont.
Tenders on the erection of a garage for A. Venator, 222 John Street North, are now being received by the architect, E. B. Patterson, 143 Wentworth Street North. Brick construction. Estimated cost, $10,000.

Laval de Montreal, Que.
The estimated cost of the proposed aeroplane factory for the Dominion Air-

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